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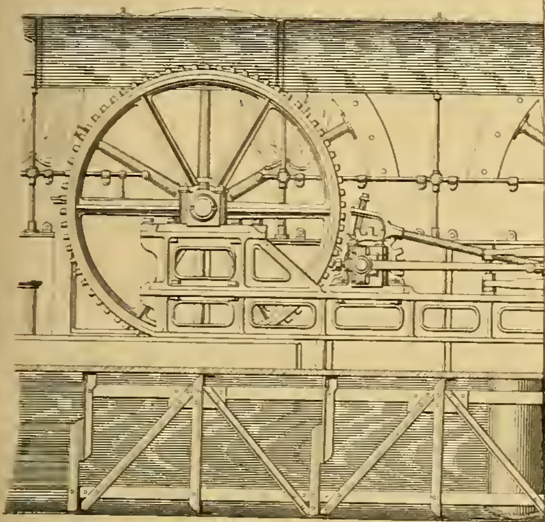

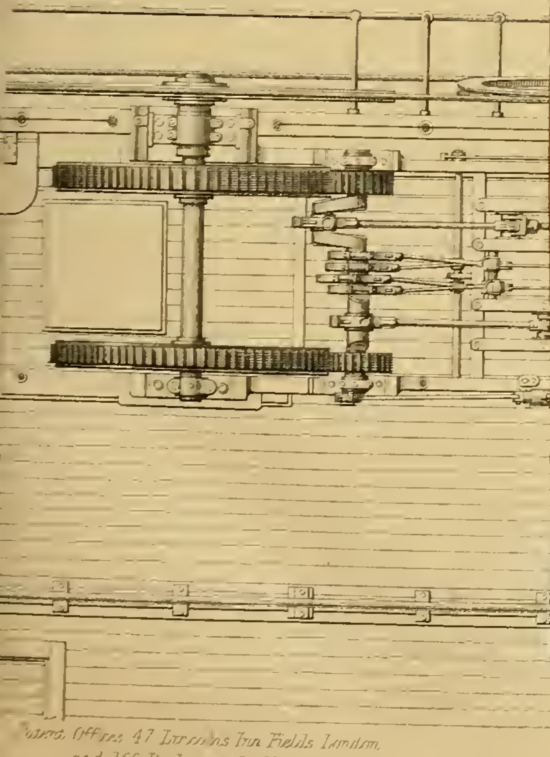

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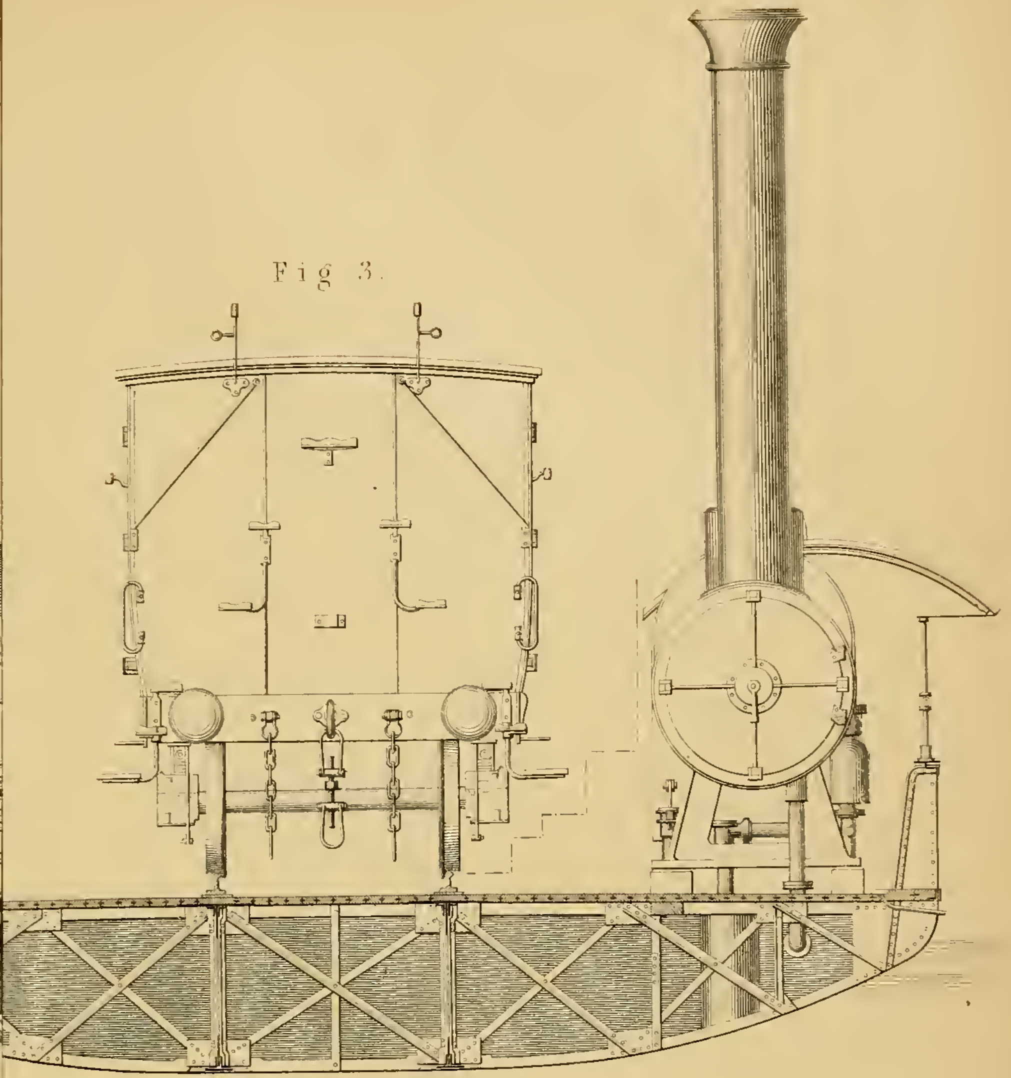

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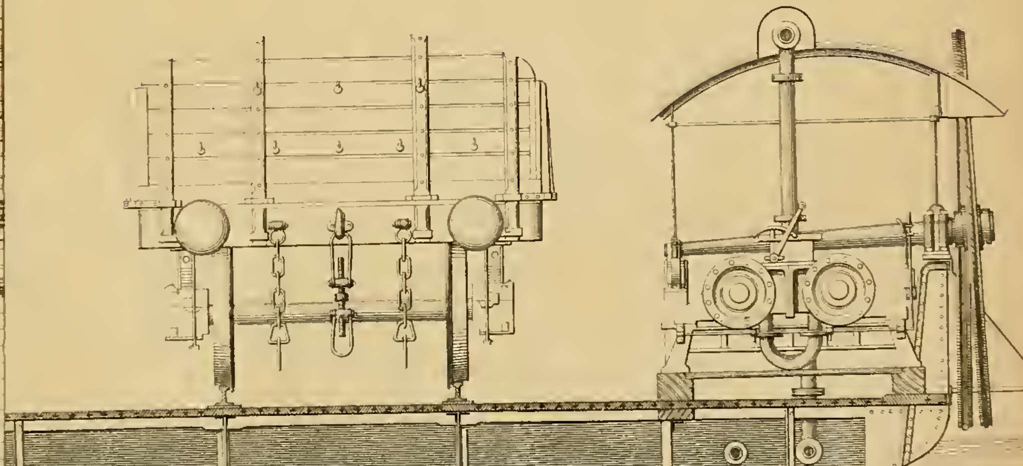

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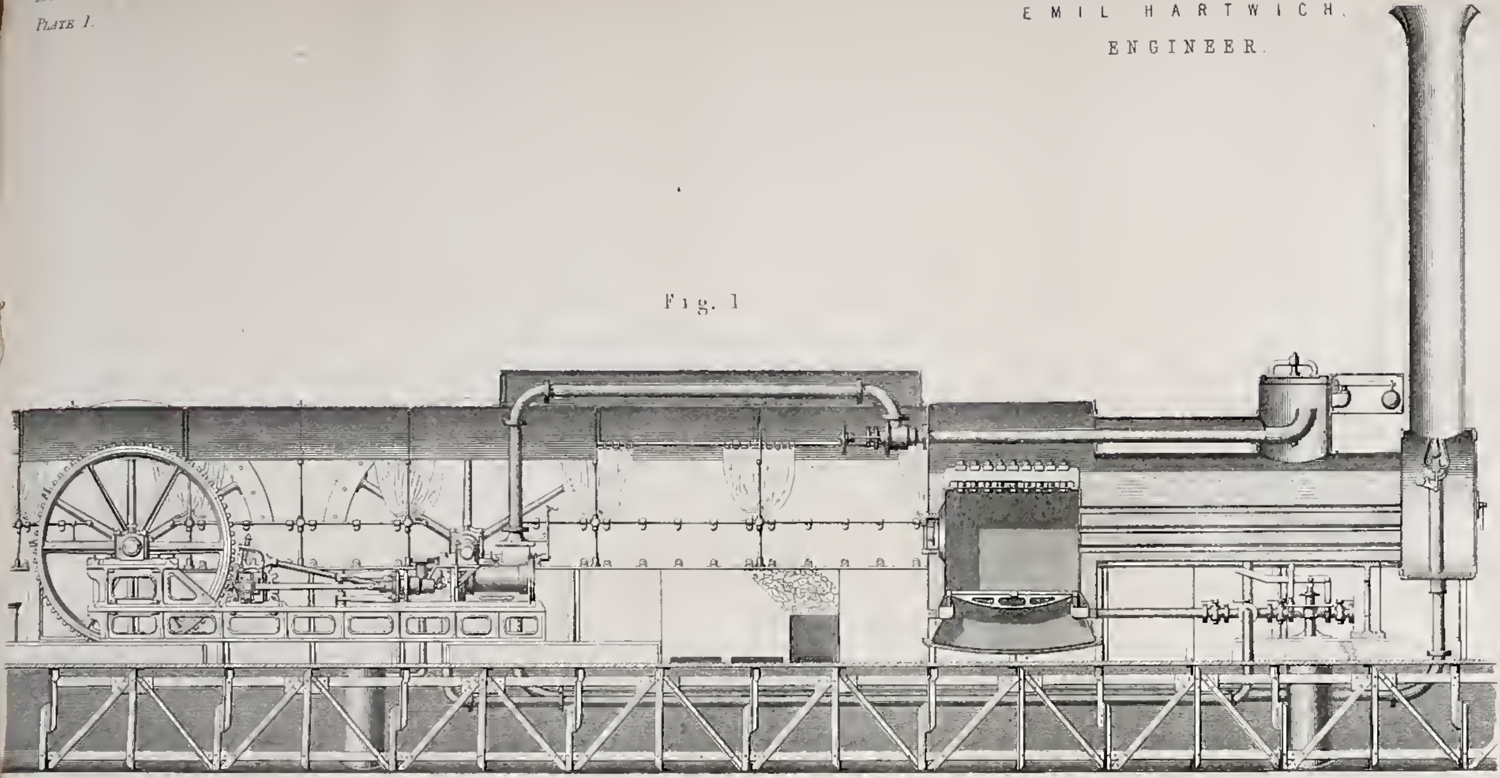
RAILWAY TRAIN STEAM FERRY ON THE RHINE.

EMIL HARTWICH,
ENGINEER.

Fig. 1



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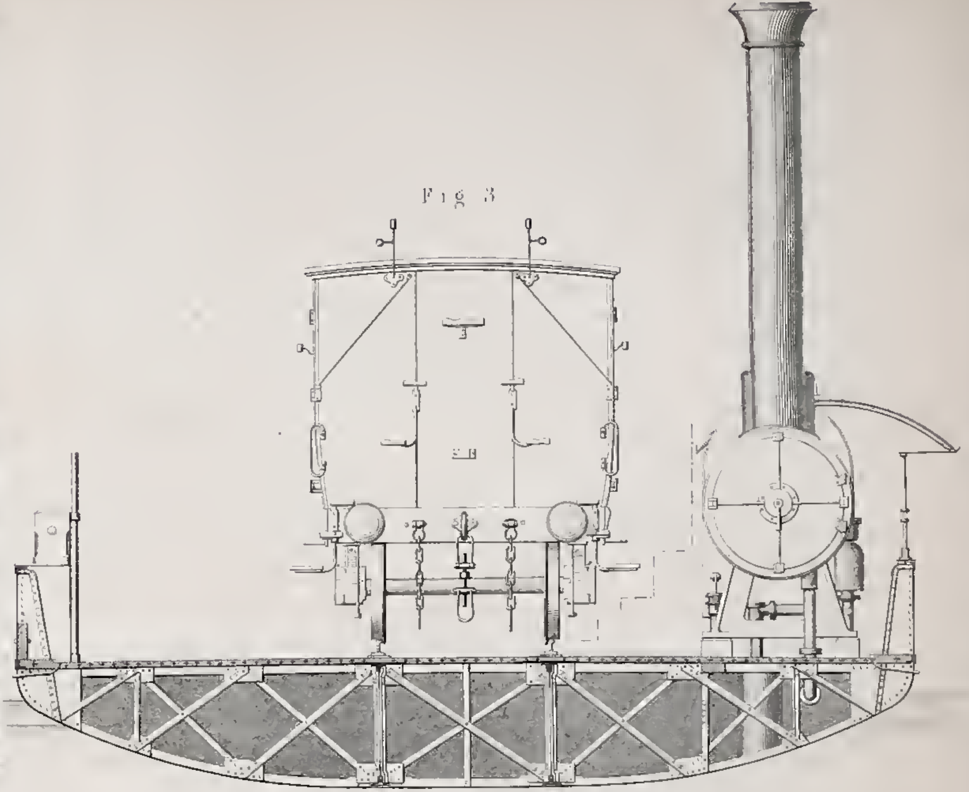

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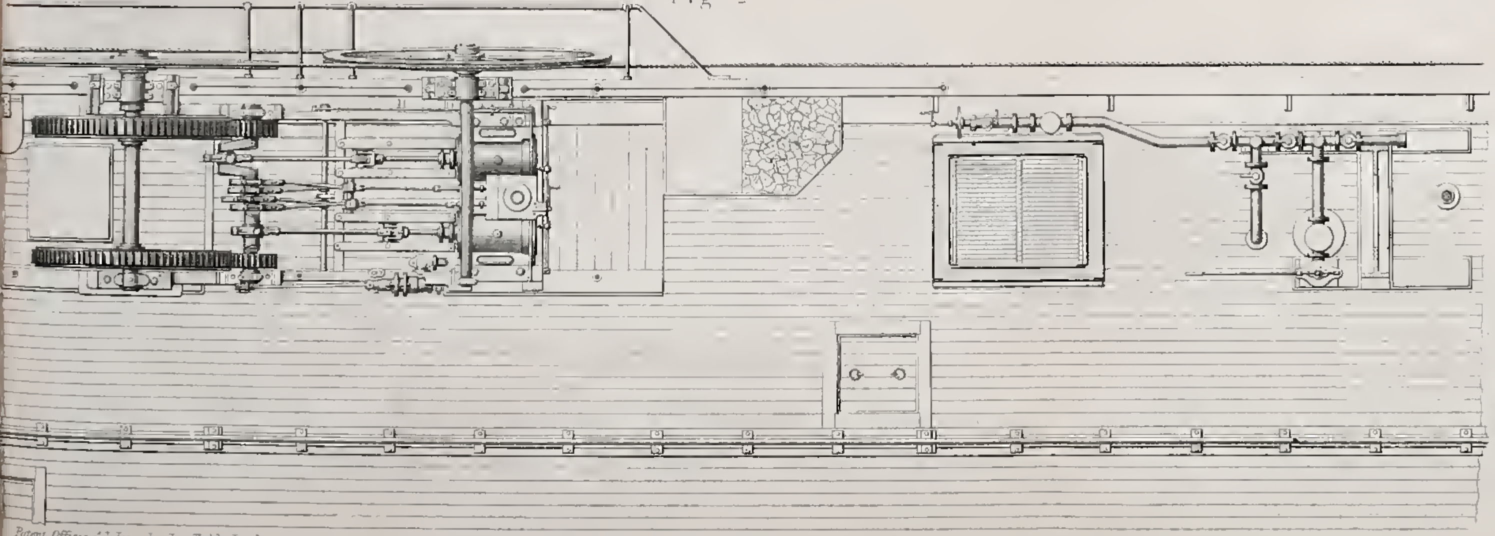

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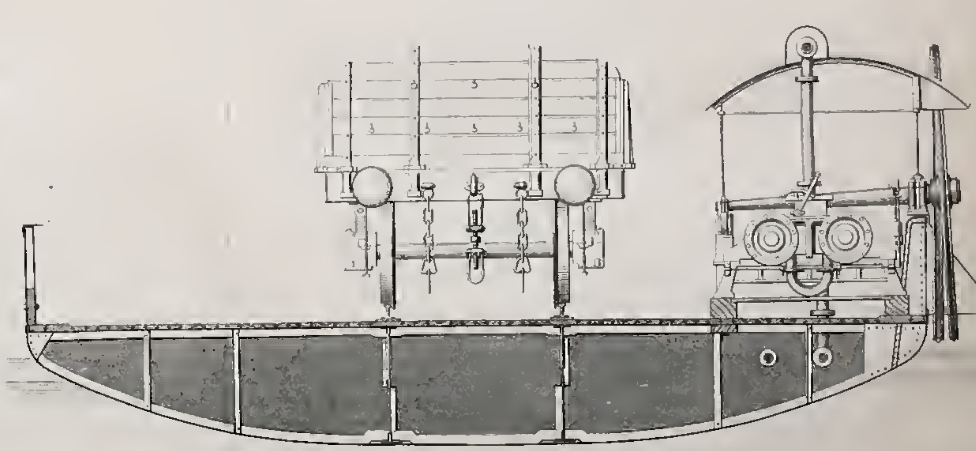

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THE
PRACTICAL MECHANIC'S
JOURNAL.

BOILER EXPLOSIONS OF 1867.

THE reports of two of the Boiler Insurance Companies of late years which have sprung up, viz., that of the Midland Steam Boiler Inspection and Insurance Co., and that of the National Boiler Insurance Co., both for 1867, are before us. Both are by the engineers of their respective companies, and are creditable to their authors.

The report of Mr. H. Hiller, the engineer of the second above-named company, is well classified and arranged as to the natures of the accidents (as they are charitably termed), and suggestions for prevention. In his district there were forty-two explosions during the year, resulting in fifty-eight persons killed, and eighty-one seriously injured. Of the forty-two explosions just one-half, or twenty-one, were due in equal proportions (seven to each) to external corrosion, overpressure, and malconstruction. In other words, one-half the *accidents*, each of which cost in round numbers one human life and a half, were due to ill-made, or ill-worked, or worn-out boilers.

Mr. Edward B. Marten reports as engineer for the Midland Steam Boiler Inspection and Insurance Company. His classification is not as elaborate as in the preceding case, but the report is rendered practically valuable by a large number of well executed wood-cut illustrations of the chief cases of exploded boilers, which indicate clearly and suggestively the nature of the forces concerned.

In this district Mr. Marten reports forty-eight explosions within the year, causing the death of seventy persons, and the grievous injury of eighty-eight others. Of these forty-eight explosions no less than twenty-seven are attributable to malconstruction (fifteen), overpressure (five), or being worn out (seven). These statistics would be of very much greater value if it were practicable, as no doubt it must be, to ascertain the total number of boilers of all sorts in the area over which the report extends. As it is, we are quite unable even to guess at what may be the percentage of boilers which blow up within a given area, and within the year, in proportion to those that conduct themselves with greater peacefulness and propriety. But though we cannot reach this, we have far more than enough here to prove the fearful though silent and almost unnoticed sacrifice of life and limb, and the terrible amount of misery to survivors produced day by day in those regions where steam power is in much use, and the absolute and undeniable necessity for extending to our country universally the same sort of law, as to government regulation and inspection of boilers as of all other trades and instruments that endanger life and health, which has so long and so beneficially existed in Germany and France.

It is appalling to cast the eye back upon the human holocaust that is yearly slaughtered, through what we are pleased to call accident, in connection with traffic and manufactures in the two British islands. London street traffic produces its more than 300 victims; probably as many more could be found had we returns from all the rest of the great towns; the railways give us about half as many, we believe; the mines and collieries average about 1000 per annum; shipwrecks we shall not meddle with, nor accidents by fires. Here, however, we have steam-boiler explosions alone reaching in two small districts of England nearly 130 killed per annum. Had we returns for the whole of the British Islands, we shall probably not be far wrong in assuming that from 350 to 400 persons are killed, and double as many maimed, by boiler explosions every year.

Now whatever may be the case with regard to losses of life through city and railway traffic, and that upon the seas, and as to which, no doubt, we must admit the force of the remark with which the world in effect coolly dismisses these, viz., that "we can't make omelettes without breaking eggs;" it admits of no doubt that were supervision of our mines and collieries not a make-believe and, to use the vernacular, a humbug, but a reality, by having an adequate number of able and efficient mine inspectors, and paying them so well, as also looking after them so well, that their duty should be rigidly and impartially done, and enforced on others, then might the number of accidents in the mines and collieries be vastly diminished, and brought down much below what is even the continental coefficient of death in the pit. But as regards steam boilers, it is obvious to common sense that under a proper system of supervision *and control*, loss of life could be made to cease absolutely and totally, excepting in the very few cases which would remain, as justly coming under the category of accidents properly so called; namely, explosions due to some fortuitous event or combination of events, such that human foresight as ordinarily well exercised had not been able to guard against.

A few such events must always be expected; but to call such things as six explosions of domestic kitchen-fire boilers (killing five people on their own hearths) *accidents*, because these boilers had been made hermetically close vessels, otherwise than by the supply water pipes and the out-draft cocks, and which were frozen up, has about as much sense in it as it would be to say that a man who had deliberately lighted a grenade, and held it until it exploded, had been accidentally killed.

The manufactory boilers are quite in the same category; it is only that the chain of causation is here and there a little longer, or the links in it a little more out of sight; the nature of the case is as plainly matter of mere foresight and habitual watchfulness and caution in one instance as in the other.

We have no wish to say one word against the existence and work of these boiler insurance companies, unless it be so far as their existence may tend to blind the vision of the public and the legislature to the real necessities of the case. But we do unhesitatingly affirm that even if such companies were spread over the length and breadth of the land, which is not possible, and were greatly more on the increase in efficiency and in success than they are or are likely to become, viewed as what they really or mainly are, mere financial associations looking to a money result, they never could produce any serious or sufficient reduction in the amount of steam-boiler accidents. The reason of this is not far to seek; they are mere voluntary associations, devoid of the slightest power of control or of compulsion beyond that almost nominal amount that is supposed to spring out of the mutual moneyed interests of the insurers and of the insured. The real cases that demand inspection and control, are just those where insurance would always be viewed as of quite secondary importance.

A needy or reckless manufacturer who had had a boiler insured, and whose financial or other circumstances strongly induced him to work it after it was dangerously worn out, or to a higher pressure than was safe, would not alter his course, or very probably would plead that he *could not*, because the boiler insurance company refused any longer to insure for him; he would take the risk and the consequences, because the unseen and possibly never to occur danger of explosion was a less present evil to him than to stop work, and go to the expense of a new boiler, with an already overdrawn bank account, or to be late with the completion of orders the fulfilment of which alone could stave off insolvency, by working his inadequate boiler to a higher pressure than it was intended for, or was safe at.

These are extreme instances possibly, but there are thousands of cases in which more or less of such overmastering motives prevent volunteer associations, like these boiler assurances, from being much more than fine-weather guardians. At the very most, all that can be said for them is, "This ought ye to have done, but not have left the other undone." There is not any objection to be urged against them, except they never can result in any considerable good, nor fulfil the functions of state control. That, we affirm now, as we have done long ere now, ought to be without delay extended by the legislature over every steam boiler in Great Britain.

The writer of this article is personally cognizant of the nature and working of this state control in France, and more minutely and fully of that in Prussia, and can testify that it produces no annoyance to the manufacturers or to any other class, but, on the contrary, is recognized by all as a most wholesome and beneficent safeguard. It is in both countries a real *control*, not a mere useless doing of the goose step of supervision or inspection, without any power behind, as is the case with our railway inspection under the Board of Trade. At the design and creation of the boiler, the engineer or boiler maker is not harassed by any vexatious interference with his arrangements or proportions; the state tells him that the science and experience of its engineering advisers have pointed out certain proportions as advisable: he is not bound to follow them, but before the boiler when made, can be set to work, the state through its officer steps in, examines and proves it, and, if all be right, certifies that it is so, and gives authority to go to work. Periodical inspection then must be submitted to; the intervals are not long; the inspection is not a sham; it is a real examination, and, if need be, a repetition of proof and a renewal of the formal certificate, permissive of work.

If any repairs, however trifling, be required to a boiler, a simple form of notice *must* be addressed to the nearest communal inspector, who, thus informed, uses his own discretion whether he shall require the parties to enable him to examine the boiler after the repair and before it goes to work again. In whatever instances these formalities are fulfilled, the manufacturer, or coal owner, or miner, has really no trouble, nor is a delay of an hour needlessly given him, for there are plenty of inspectors at hand, and these are competent men. But if the reckless or impatient man should try to evade the law, he is very soon found out, and finds out his mistake to his cost. The writer knew of an entire colliery in Westphalia being stopped and kept idle for forty-eight hours, in consequence of the managers having executed a repair to the steam chest common to all the boilers of the winding engine, without having sent in the customary notice to the district inspector. They had done so before, and equally causelessly, and the inspector determined to read them a lesson. Adequate means are always at hand to find out what is going on of this sort; and so the managers on the same Friday that the repair was completed—it only occupied about three hours—were startled by receiving a prohibition to work the boilers until after inspection again. They went personally to the inspector to cry *peccavi*, and get their sentence if possible commuted; but the inspector, it was found, had gone to another and more distant part of his district to examine new boilers, and they must now wait his return.

Here, now, is a salient example of that "pestiferous interference with private rights and actions" that makes such fine stump oratory and newspaper writing against "paternal governments" in the mouths or from the pens of Englishmen. But is the case one of any real hardship? those that will break the law, which is for the protection of all, have most righteously to suffer for doing so. Which is best, that those who deserve it should so suffer, when more regularity in obedience, proves that its yoke is easy and its burden light? or that those who don't deserve to be injured, should be left at the mercy of those who are ignorant, reckless, or grasping, and therefore try to evade the law?

The inspection, too, is, as we have said, a real one: the staff of inspecting officers, the system of notice, examination, proof, record, and report, are not of the beautiful hap-hazard sort, so characteristic of every institution almost, in this "free and independent nation." It has all been thought out and arranged with the foresight and wisdom that belong to the legislative and social arrangements of France and Germany. Each smallest district inspector is himself inspected, and has to report to an officer above him; and, finally, the whole of the official system condenses its annual results and reports at head-quarters, and government has before it at a glance the entire workings. Nor is the steam-boiler owner left by the law at the mercy of a cantankerous or exacting, or possibly venal, inspector; he has his power of complaint, of investigation, and of remedy, if justly demandable, close at his elbow. In effect, nothing can work better or more smoothly for all concerned than does the system in Prussia, and we believe it does so nearly as well in France, though in the latter country the law is in some few respects a little more exacting, and the power put in the hands of individuals rather more stringent. At the present time, when the public mind is busy with the important—we admit, *more* important—subject of education, primary and technical, it is not amiss to urge the necessity of legislatively taking care of the bodies of the working class as well as of their minds; and now, would be a most suitable moment for a complete reconsideration and consolidation into an adequate and symmetrical form, of our mine inspection, our factory inspection, and of a comprehensive system of inspection of all that comes within the scope in France of "insalubrious or dangerous arts or manufactures," including in this steam-boiler inspection. It would be now easy; in some years to come, if these boiler insurance companies multiply, vested interests will arise in them, and personal opposition have to be encountered, and difficulties, which as yet scarcely exist, will have to be met in Parliament. We do not think these companies are likely to extend very fast; they have not done so as yet, and the more they shall, the more their utter incapacity to deal with the evils will become apparent.

"During the past year," says Mr. Hiller, "four instances have occurred where explosion has been ascribed to deficiency of water, and blame thrown on the attendants *who were killed*. In these cases I believe that the juries (coroners' juries) were entirely misled by the erroneous character of the evidence. The chief officers of this and other institutions are always ready to render their services in matters of this kind, and in the interest of both boiler owners and of the public generally, it would be well if all cases of explosion were investigated by them, or some one of equal experience, in order that the juries may not be led into returning mistaken verdicts."

What a picture is here dimly seen in *chiaro scuro* of that time-honoured institution of "crowner's quest law"—an old world thing utterly incompetent to deal with the complicated questions of science and practice, that these so called "accidents," as well as a thousand other incidents arising out of our modern arts and manufactures, are daily giving rise to. Somebody is to blame in nearly all of these; what chance is there of getting at the truth, when twelve men picked up at hazard out of the highway, are called upon to decide what if honestly spoken out, may influence the pockets or reputation of those neighbours whose wealth or connection, &c., influence them? How is truth to be got at when these mostly illiterate men have "scientific evidence," or what is often far worse, the dogmatic unreasoned dicta sworn before them of so-called "practical men"—"men in the trade"—"men of great experience," and so forth—who are produced sometimes much at hap-hazard, but more commonly "to order," by one party or the other of those implicated, and who have looked about for exculpation for their retainers?

Doubtless the evidence of competent men, holding known positions, such as Mr. Hiller, or Mr. Marten, or Mr. Fletcher, would be greatly to be desired in place of this. But is absolute impartiality to be surely anticipated in all cases from engineers who have clients *in* these boiler companies who may get into scrapes, as well as those whom they have no anterior relations with? We are all fallible, our minds are easily warped more or less too, in dealing with questions as to which we have been known to have enunciated fixed opinions, and to have publicly acted on declared maxims more or less correct.

Here then are many and grave grounds for taking the investigation of boiler explosions and accidents, if not away from the coroner altogether, at least making him take for his examinations as to fact, and for his assessors, those officers of government inspection whose appointment we urge, and who should be by position as to district, as well as by scientific and social station, above the reach of any local or of any other deflecting influence. One sentence in Mr. Hiller's report alone is sufficient to show the entire inadequacy of the "voluntary system" of these boiler companies, even in such a close, dense region of steam, and amidst so intelligent and lively a population of manufacturers as that about Manchester:—"A large number of firms have not yet insured, nor placed their boilers under the inspection of any company, chiefly, I believe, through a misapprehension of our advantages. I beg to remind those owners that our inspection is not intended to supersede their own care, or that of their servants, but to assist them in every way. Where desired, we undertake the periodical inspection of boilers without insurance. I trust that all boiler owners will, by their voluntary action, procure such inspection of their boilers as will render unnecessary that government interference which has so often been recommended."

Just so; "the voluntary system" here, as everywhere else, in education and the rest, proves a failure. It is mighty good, where, and so long as, "the wishes are father to the wills" of those who employ and applaud it But let the former run counter, and the volunteering becomes a rope of sand. So it is with the boiler owners. It is just those who most need inspection that don't wish to have it; just as the brickmaker who prefers the shilling or two a week he gets out of his children of seven or eight years old, compelled by him to drag wet bricks when they ought to be at school, prefers the voluntary system, and deprecates any government interference. But state supervision, and within just and mild limits, state compulsion, are just as much wanted, and would be as wholesome in the one case as in the other.—Ed.

PRESS FOR BENDING ARMOUR PLATES.

CONSTRUCTED BY MESSRS. ALEXANDER MORE & SONS, ENGINEERS, GLASGOW.

The engravings represent, at figs. 1 and 2 respectively, side and end elevations of a hydraulic press which has been constructed by Messrs. A. More & Sons for Messrs. Robert Napier & Sons, Govan, the eminent shipbuilding firm, for the purpose of bending or setting thick armour plates to the curves necessary for fitting the sides of our ironclads. The third figure is a front elevation of the set of three pumps by which the hydraulic pressure is produced; fig. 2 showing the end elevation of the pumps in the position under which they are applied to the press. The pumps are driven by a belt passing over the driving pulleys, shown at figs. 2 and 3, and of the construction for which this firm has long enjoyed a reputation, and such as they usually supply for the different forms of powerful hydraulic machinery which they are chiefly employed

Fig. 1.

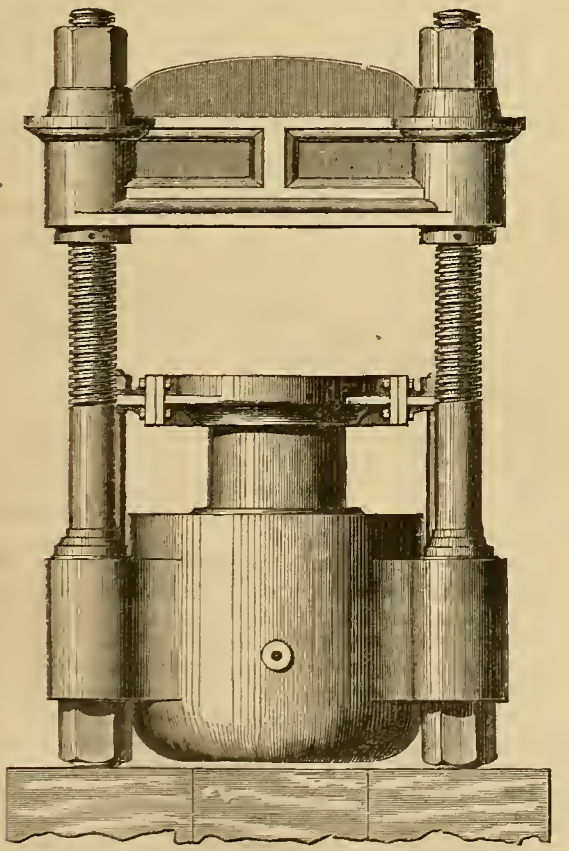


Fig. 2.

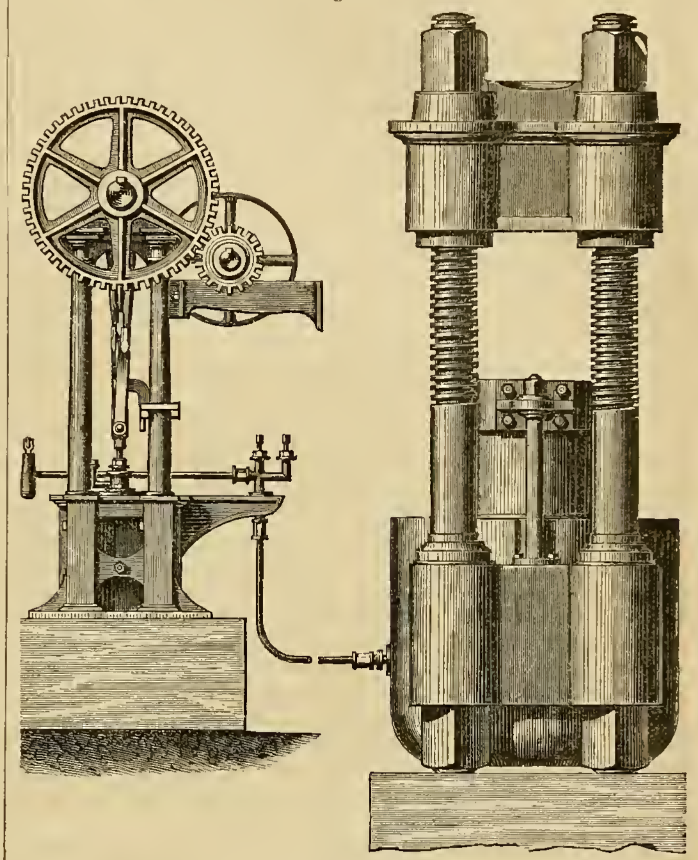
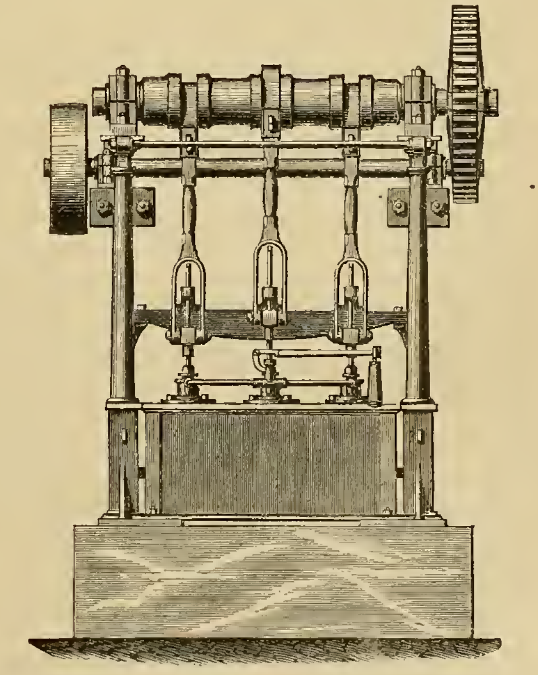


Fig. 3.



in manufacturing. To the practical eye the engravings fully explain themselves, being prepared from drawings placed at our service by the firm. It is, therefore, unnecessary to give further explanation.—V. D.

MR. FAIRLIE'S SYSTEMS OF LOCOMOTIVE ENGINES.

DOGMATISMS and their authors, as well as dogs, have their day, and their day only; though their lives are always long in proportion to their authority, which is the co-efficient of dogmatic power with the chief part of mankind.

In very early railway days the Stephensons announced as one of the articles of belief, based in the *cosmos* and not to be gainsaid, that no railway with a ruling gradient steeper than 1 in 250 could be worked with economy, therefore with advantage; and Dr. Lardner followed by an equally dogmatic oracle, that no railway with a curve upon it of less than a mile radius could be worked with safety. These articles of belief, however, like the credence in witchcraft, whatever grain of truth they had in them, have died out, and engineers now act upon principles not a bit less exact as regards the recognition of natural laws, but with a far broader appreciation of conditions.

Without denying the fact that a very slight increase of gradient may double the tractile power necessary, nor Lardner's truths as to the relations between curve-radius, centrifugal force, and flange friction, &c., they now see that far wider and more complicated conditions—financial, social, political, military, fiscal, in relation to capital possible or advisable, and a thousand others—enter the question of what gradients and what curves it may be advisable to adopt in order to secure the formation of a line of railway between given points. They know full well that, whatever may have been done upon the comparatively level bed of consolidated mud and dirt of which our own larger British island mainly consists to the southward, the configuration of the crust of our globe itself forbids the possibility of uniting distant continental provinces or kingdoms, separated by great natural barriers from each other, unless by the adoption of steep gradients and curves often of extreme sharpness. Theoretic exactitude remains just where it was, but it has to submit to be shelved in presence of the actualities, which, if they are to be met at all, can only be met by compromises.

Very much the same review might be had of the history of locomotive-engine improvement and extension since the days of the memorable Rainhill competition, when the locomotive really first sprung into existence, by revealing at once all its before unexpected power and speed—unexpected, beyond doubt, even by its then constructors, or, as the Stephensons are even still popularly deemed, its creators—like Minerva springing in full panoply from the brain of Jove. And yet the differences in the subsequent careers of the railway and of the locomotive, have been quite as curious and instructive to trace. At first lightness was deemed indispensable in the locomotive, the condition without which it was assumed that speed was impossible. But the Rainhill trials dissipated that bit of theoretic mist at once, and showed that power, *i.e.*, rapid generation of steam at high pressure, was the condition of speed.

The effect of lightness soon began to show itself in want of adhesion in proportion to the load to be drawn; and then at once began that career which is even yet not ended, in which the ever-expanding wants of traffic have urged on a continually increasing weight of engine, necessitated at once by the need for greater evaporative power, higher pressure, and the machinery to employ these, and by the equally imperative demand for adhesion, or grip of the rails, to drag the heavier and still heavier loads. From this has followed continual increments of weight, strength, and cost of permanent way to bear all this; and at last a limit begins to be seen, at least to the possibility within contemplable cost, of extending the resistance and endurance of permanent way, even when steel rails shall have (as no doubt they will) become very largely, if not universally, the substitutes for iron ones: yet the limit of the demand for haulage, and the accessions of weight and power in the locomotive, still goes on.

Dogma has but little affected the history of the locomotive: theory, worthy of the name, had little to do with it until after it had sprung into existence an almost completed machine. Thenceforward its history nearly to the present hour, though illumined by many able contributions from science or theory, has really been little more than groping trial and error. One man has added this, another improved or modified or adapted that: better tools, more capital to work them, general metallurgic advances, special shops for locomotive building, the concentration of many minds of a high order upon a vast and lucrative industry, and the pressure of competition (both in the engine maker's and the engine employer's cases), have all converged to make the locomotive of to-day the splendid instrument of power and monument of human skill and perseverance that it presents to us, in its finest types, at the present hour.

But with all this it is marvellous to observe how the great outlines, "the archetype skeleton," as it were, of the oldest designs, remain as those in which all these multitudinous improvements in detail inhere. In general form, in fact, the very best types of engines upon nearly all our great British lines do not very materially differ from those of engines built a quarter of a century ago; and however improved they may be as to detail, it is because in maintaining these types we shut our eyes to the glaring evils and difficulties which they inevitably bring adherent with them, that locomotive power remains the wasteful and tremendously costly element of railway traffic which it is well known to be, to those initiated into railway management and accounts. The early locomotive had "a tender" to carry its water and fuel, and except in tank engines, which are themselves exceptional, we have a tender still. It was a light affair at first, for the evaporative power and distances run did not demand a great load of water or of fuel; but it has been always growing, and the weight of the tender itself has grown out of all proportion to the load put upon it. The greatest proportion by far of the gross weight of the tender consists in the wheels and axles, springs, brakes, framing, and plate surfaces. It not uncommonly weighs 12 to 15 tons, while its useful load is often as small as 2 or 3 tons; yet all this must be dragged along; its ponderous wheels and axles are of no real use but to give the structure something like proportional inertia, to prevent its being, in fact, as a mere tin kettle at a dog's tail between the heavy engine and the heavy train, and to enable them to perform the functions of a brake carriage to both of these.

It seems an incredible thing to find a passenger engine, for example, on the broad gauge, with the six-wheeled tender, together running on *seven* pair of wheels, and yet out of all these seven only one pair effective for traction: this one pair of driving wheels made to crush into the rails by an insistent pressure sometimes of 15 or 16 tons upon them, in order to get bite enough to be able to drag all the other useless dummies or rollers after them: to find that of the gross weight of the engine and tender in running order (11 tons being water and fuel), viz., 61 tons, no less than 47 tons is dead load, useless so far as having anything to do with the traction of the load behind is concerned, except to produce steam, and to expend it in power upon the one pair of driving wheels: to find that the loaded tender weighs nearly 24 tons, and does nothing in the way of service, but carry the fuel and water to make the steam, and interpose its own mass as a buffer, it may be, between engine and train, and act as a brake when stopping is needed. Brunel at a very early period saw some of the inconsistencies of this, and made some costly but abortive attempts to remove them. Hawthorn, of Newcastle, more than twenty-five years ago, built from his designs a compound sort of engine, in which the boiler was placed on one frame and carriage, and the engine, with ten feet driving wheels, and water upon another, the boiler carriage having the brakes; but still, of the four pairs of wheels and axles, but one was of any use for traction. The tank engine attempted to get rid of some, at least, of the unproductive load of the tender; but here new difficulties, through adherence to ancient types, were soon met. R. Stephenson had lengthened out the barrel and tubes of the boiler; he and others had wisely lengthened out the fire-box, or even put one behind another; and he had adopted what the United States had originated, the substitution of the bogie for the two rolling pairs of wheels and axles of the engine. But the "bogie," on the whole, met little favour in England; it was ill designed, and worked stiffly and even unsafely, and in the main all British locomotives held fast by the time-honoured models, and bad rigid framing and rigidly parallel wheels and axles. The wheels were long, limited to four, then came six, and at last two of these coupled at each side. A short wheel base was deemed, and justly while things were so, indispensable to safety in going round curves. Mr. Bury, while he ruled upon the northern end of the now London and North-western, insisted that more than four wheels to any engine was dangerous on this ground, and, in fact, gave up his post rather than his opinions. This was long before Adams had devised his swivelling axle bearings, even yet an exceptional appliance, if even a perfect one; and "coning" alone did whatever was done, to enable a six-wheeled engine to grind round a curve of anything like short radius. Hence the length of wheel base was as rigidly limited as the parallel axles and frame were themselves rigid, and so even with six wheels the Stephenson long boilers were found at high speeds, and with a road uneven or out of order, to plunge and "gallop" in a fearful way; and here was and is one of the limits of the tank engine—whether the water load be distributed below the boiler or saddled up above it, or both, the centre of gravity of the whole structure is probably always, but certainly in the latter case, raised, and the fuel upon the foot plate adds its weight far towards one end. The overhang of load beyond the length of wheel base becomes greater still, and the "galloping" plunge of the tank engine at speed becomes far worse than in the long-boiler engine alone, not only because of the distribution of the load over the same short base, but because the inertia of the load itself is increased. But another class of reasons set a limit to the use of the tank engine: upon the three or even four pair of wheels it is not possible to find room for enough water and fuel to carry a heavy engine through a long stage without stopping, such as from Rugby to London, or London to Brighton. The tank engine is thus the merely exceptional instrument of small or short traffic, and the useless dead load of the tender, as well as its tremendously heavy structure, remains the rule throughout Great Britain.

But were the tank engine universal (and it is far more common on the Continent than with us, and arranged to run longer stages), still it can do nothing for the "adhesion difficulty." With our best-laid permanent way, a rolling load of more than 5 tons upon any one wheel, means the rapid destruction of the way, and proportionate cost for restoration. With a rolling pressure approaching double this upon any one pair of wheels (6 to 8 tons not being uncommon on driving wheels), and especially with steel tyres, the rails themselves are crushed into, rolled out upon the top table, laminated into shreds, and destroyed. Yet this is what *must* be done when the entire "bite" for the traction of a heavy train must be provided for and got out of a single pair of driving wheels. The insistent *static* load is no doubt less upon each wheel where two pair of drivers are coupled; but were we to spare space enough to go lengthily into this subject, which from its ramified and conditional nature we feel cannot be done full justice to otherwise, it might easily be shown that with such coupled wheels, and the existing types of engines, the static pressure upon each pair of wheels is very far from representing the actual destructive energy of the same upon the way. In fact, two pair of drivers may be coupled; the static load upon each wheel, as proved by the weigh bridge, may not exceed 5 tons, and yet the hammering power, *quoad* the rails, of the pair farthest away from the centre of gravity of the engine, may be as great as that of a single pair loaded with 6 or 7 tons each, situated close to the centre of gravity: and in this case we will assume an engine well balanced as to its working parts; if these be out of balance the plunging of the leading or trailing pair of drivers will be further exalted.

The limit having been reached at which no more pressure upon driving wheels is possible upon a given line of way, unfavourable gradients, time, or heavy traffic still urging for better haulage and better bite, the expedient is resorted to of working with two engines. We do not here go into any consideration of what this means or infers in point of drivers and stokers' wages, repairs, interest on capital in rolling stock, and so forth. One engine very generally runs backwards; in other words, its trailing wheels become leading wheels. As one element of allegeable use in the ponderous dead weight of the tender is, beyond question, that being coupled hard on to the engine and dragged behind, its mass tends to steady the plunging of the engine due to its narrow wheel base; so here, the two tenders, no doubt, do tend to steady both coupled engines, and reduce the amount of risk that is always run by running engines backwards. But no engine whose heaviest insistent pressure is upon a central pair of driving wheels, with much smaller diameters of leading and trailing rolling wheels, ever *can* be a safe rolling system. It is demonstrable upon simple principles, that the maximum of safety as against leaving the rails upon either a straight or curved line will, *cæteris paribus*, exist where the leading wheels, being also those of largest diameter and the most advanced in the engine, are the driving wheels, and when all others are following or trailing wheels. This, although exceptional constructions can be pointed to, may be said to be impossible with our common types of locomotive. The directive power of coupled driving wheels when thus posited is, upon a perfectly straight line, amazing. The writer was last summer upon the Northern of France Railway when a six-wheel (four-coupled leading drivers) locomotive, hauling an express train, was thrown partly off the rails, by either a bad joint or a hollow sleeper. The two leading driving wheels were thrown off only, and in that state the engine and train ran along for more than half a mile before being stopped; the wheels that were off, keeping all the way so close to the rails as to shear off the fish-plate bolts nearly all along the track, and yet never diverging further. Without six wheels, this could not have occurred, but with six wheels, had the middle ones alone been drivers, the engine would probably have been over the side of the embankment of 35 feet high, where the accident occurred, within the first 200 yards.

Nearly all our engines are in fact, in type, *one-ended.* They are only designed to run with greatest safety—be that more or less—always with one end foremost. Hence the whole ponderous system, upon all our lines, of 45 or 50 feet turn-tables, and all their attendants, and consumption of time and labour and capital, &c.; all the latter of which are doubled when two engines are employed as mutual assistants.

Now, all these disadvantages or evils hang together like "the house that Jack built." We can't dispense with a destructive pressure upon single pairs of driving wheels, because we must have adhesion; we can't distribute that adhesion amongst all the wheels under the engine, nor make the whole weight borne by all the wheels available for adhesion, and therefore useful for haulage in place of a mere rolling incumbrance, because we can't extend the rigid length of wheel base, and yet get round curves even of moderate radius, without danger of a smash; we can't diminish greatly the radius of our curves on new lines, nor employ very steep inclines, both of which are of the essence of economy in construction, because we can't get round sharp curves, and have not, with all the pinch on the two or four driving wheels that we dare give, enough adhesion to drag up heavy loads; we can't get rid of the useless incumbrance of the tender, because we can't carry enough water and fuel safely in any other way, or upon any ordinary type of engine; and we can't get rid of turn-tables, because we must turn our engines to enable them to run with the best amount of that moderate safety, of which only they are susceptible; and finally, we cannot materially increase power for a given total weight of engine, or even for a reasonable addition to it, because the diameter of the boiler is fixed by our unlucky 4 feet 8½ inch gauge, its height above the rails throws the centre of gravity already dangerously high, and the length cannot be extended, because that of the wheel-base cannot be so.

One can see without probably much uncertainty that in a remote future, after the 7 foot gauge shall have long been absorbed and lost in the narrow or 4 feet 8½ inches, that new and future legislation to meet future needs will compel all the lines in the kingdom simultaneously to enlarge the latter gauge, and adopt either the Irish gauge of 5 feet 3, or the Indian of 5 feet 6 inches; and whenever, if ever, that may take place, we can obtain more power through more boiler room; but that is a contingency not worth present speculation upon. What then is the clue that can bring us out of this labyrinth of difficulty? Mr. Robert F. Fairlie, C.E., has given the answer within the last four years or so, by inventing and bringing into a practical working condition of his several designs of patent locomotives, and we do not shrink from uttering with clearness our opinion that he has given a full, distinct, and almost complete answer to the question. Parts of it had been answered before; the continental locomotive engineers—more original and exact in thought generally than our own, more alive to and more ready to change from old to new, and above all, less hampered with utterly unpaying lines on the one hand, and the ceaseless crush of an overwhelming and leisure and thought absorbing traffic on the other—have long been before us in surveying the difficulties at which we have here taken a rapid glance, and in devising more or less of remedy. As long ago as 1862, at our London Exhibition, Messrs. J. J. and A. Meyer, of Vienna, showed their articulated tank locomotive, in which (see our Record of the Exhibition, 1862) upon two distinct frames, each mounted upon six wheels all coupled, the engine is placed. Each frame had a pair of cylinders of its own, which drove all its three axles and six driving wheels, upon the whole twelve of which and of both systems, the insistent load was evenly divided, so that the whole weight of the engine was available for adhesion; and as both frames swivelled separately, like two large bogies, so a curve as short as could be gone round by the length of wheel base of either, could be safely traversed by this engine of 60 tons' weight, though pressing only with 5 tons upon any one wheel.

This engine was guaranteed to take itself and a load of 153 tons up an incline of 1in 17, at 10 miles per hour. At the Paris Exhibition of last year were several engines, Austrian and French, with these two grand characteristics of uniform and light pressure, ample adhesion by coupled multitudinous wheels, sixteen or twenty in some cases, and swivelling frames or bogies to admit of going round short curves. It is nothing to us here at present how skillfully, or the contrary, some of these conditions were carried out in one or other of these various engines. But though these went so far, they stopped short of solving the whole problem; many of them were still dependent on tenders—though Messrs. Meyer's was a tank engine—and they all had one end which must for safety or by the other necessities of the case run foremost: even Messrs. Meyer's engine, though *quoad* the wheels and gear it could run with equal safety with either end foremost, must in one of the two, have the driver either like a "sculler" going where he could not see, or going with his back turned to his engine.

Mr. Fairlie, however, meets all the conditions of the problem, and thus first be says, Alter the type of your engine altogether; construct an engine that under all circumstances and conditions shall be able to run with either end foremost with equal safety and facility. That done, you have got rid of turn-tables for engines and tenders at a blow. Next, distribute the entire weight of your engine, and all its belongings, uniformly and symmetrically over such a number of pairs of wheels and axles as shall only give 5 tons maximum pressure per wheel; then apply power to all your wheels, and so make all your weight available for adhesion and traction. But for this you must have great length of wheel base, and great length of engine. Divide then your wheels and axles into pairs or triplets, according to the curves you have to encounter; place each set of these upon a distinct bogie frame, and give to each its distinct and separate pair of steam cylinders and pistons, &c. You now may safely make your boiler as long as you want; you may divide its total length as you please, nearly between fire-box and tubes; you may therefore increase your power as you need it; and as you have now ample room, and are clear of all difficulty as to intense insistent pressure, which you have diffused, make your engine a tank engine, and the weight of its own water and fuel will be useful for adhesion, in place of a useless load to be dragged.

The type of engine which he has designed to fulfil these consists in something like two ordinary locomotives, with long-barrelled or Stephenson boilers joined into one at the fire-boxes, which become in any one of various ways thrown into one fire-box, taking out at opposite ends from two breasts two sets of tubes to two funnels at the extreme ends of the engine. The wheels and axles may be in number any multiple of two greater than four; but each pair or triplet has its own pair of cylinders, and swivels in going round curves upon its own bogie frame, all the system being handled from a single or from a duplicate system of regulators and hand gear. The footboards for the drivers, the fuel platforms, and the fire-doors are at the two opposite sides of the engine; so that the drivers, who can pass over the fire-boxes or round the smoke-boxes from one side to the other, are situated when running at the mid length and safest place on the engine. The water tanks can be kept low, and though the space for fuel is necessarily somewhat restricted, enough can be secured, and it does not seem impracticable to provide larger space, even if necessary, over the boiler or part of it. These engines are no longer a mere novelty. They have long been a subject of discussion and of controversy in the pages of *The Engineer*, and other technical journals. They have been running for a considerable time on some foreign railways, and upon the Brecon and Merthyr Railway in this country, and now probably on other lines.

The following official letter has been placed at our disposal, and indicates the opinion that Captain Tyler, R.E., of the Railway Department of the Board of Trade, has formed of those engines:—

Board of Trade, S.W., May 6, 1867.

To W. L. Banks, Esq.,
Chairman, Brecon and Merthyr Railway.

My dear Sir,—Referring to our conversation in the train on Saturday morning, and your subsequent note, I have much pleasure in stating to you the reasons why I should like to see Mr. Fairlie's engine more extensively employed. It does all that a tank engine or a steam tender engine can do as regards adhesion, inasmuch as all the weight of machine, fuel, and water, is upon driving wheels, and it has the important advantages that—

1. It can run either end front with equal steadiness and safety.
2. It is well adapted for very sharp curves.

The disadvantages of tank engines increase in proportion to the speed, and inversely in proportion to the radii of the curves. They are trying to the permanent way, and in this respect far from economical. They are more trying, less steady, and less safe, as the wheel base is reduced to adapt them to very sharp curves. They are apt to leave the rails, and then to turn over, on meeting with inequalities of the permanent way.

The motion of Mr. Fairlie's engines on the Neath and Brecon Railway appeared to be remarkably easy in rounding the curves, and I should be glad to have an opportunity of testing them more severely in these respects when I am next in South Wales. He will, no doubt, further improve in construction in future engines, and I should be glad to see such an engine made for the Brecon and Merthyr Railway, and fairly tested in all respects against the tank engines, from which Mr. Henshaw appears to have obtained such good results as regards economical working.

Believe me to remain, dear Sir,
Yours truly,
(Signed) H. W. TYLER.

And in a more recent document, viz., his report to the directors of the Grand Trunk Railway of Canada, made in conjunction with Mr. C. W. Eboral, of the South-Eastern Railway, upon the condition and prospects of that line, dated December, 1867, and printed, Captain Tyler well explains the principal advantages of these engines, and distinctly recommends their adoption upon the Grand Trunk line, as the following passage taken from that report proves:—

"The engines which find most favour in Canada, and generally in America, are constructed with a four-wheeled bogie-truck under their leading, and four coupled wheels under their trailing ends. And engines of this description are now being built, to weigh about 32 Canadian tons, for future use on the Grand Trunk Railway. The tenders run upon two bogie-trucks. Six-wheel coupled engines, such as are used in this country, are apt to leave the rails on an uneven or frozen road, and it is not safe to use them in Canada. The disadvantage of the existing pattern of engine is, that neither the four wheels of the bogie-truck, nor the eight wheels of the tender, are available for adhesion; and that in order to obtain sufficient adhesion for heavy loads in slippery weather, a considerable weight is required upon the four driving wheels. It is a very important object, with reference to the durability of the rails—to which I shall hereafter refer—and especially on a road-bed which is rigidly frozen for five months in the year, to keep the weights on the wheels as light as possible. The class of engine best suited to the climate, and for the various circumstances of the case, would, I have no doubt, be an engine running on two bogie-trucks—each provided with a pair of cylinders, and four-wheeled or six-wheeled according to the work required—and without a tender. Such an engine would be peculiarly safe to travel over a winter road; would combine a minimum wear and tear, to itself and the rails, with a maximum of adhesion, and would be the most effective and most economical that the company could employ. I had the opportunity some time ago of testing engines of this description on the Neath and Brecon Railway, designed by Mr. Fairlie, and have found the principle to be good, though certain points of detail required improvement. Such engines are also in use for the sharp curves and steep gradients of the Queensland Railway."

Amongst the subsidiary advantages secured by Mr. Fairlie's construction is the not unimportant one, that with a given normal depth of water over the crown of the fire-box in his boilers, a much smaller disturbance of that depth (about one-half, in fact) is produced by the engines being upon an ascending or descending incline, than with the ordinary type of engine. This is of value when gradients of 1 in 40 to even 1 in 20 are getting not uncommon abroad.

There is probably no man, out of the direct bounds of experience in the profession of railway engineering, whose opinion on this subject is more worthy of deference and respect than is that of Captain Tyler, R.E., not only from his natural engineering talents, scientific training, and large opportunities of observation upon various railways—quite as good experience with an orderly mind and observant habits as any other—but from his well-known probity and hatred of all falsehood and quackery.

At the same time, we are bound to notice that several of the best-known and esteemed locomotive superintendents in England have raised divers objections, and uttered hard opinions of the Fairlie locomotive, several of which may be found in the mechanical journals we have already referred to. We do not wish to be rude, or to excite hostility, yet we must not avoid venturing this remark, that so far as some observation and experience go, we have been obliged to regard locomotive superintendents, as a class, as a very prejudiced set of men upon all immediate professional questions, and each prone to condemn every system but his own. Nor is this very wonderful, nor causes for it far to seek, if we were to enter at length into the conditions under which these gentlemen have acquired their knowledge generally, and the formidable responsibilities, and cares, and labours, without leisure for exact study, under which they usually have had to exercise it.

Some of the objections which we have observed made to Mr. Fairlie's engines, by whomsoever made, do at least appear to us either untenable or of very small weight. But, on the other hand, we are not ourselves insensible to certain valid objections that may be urged against them as to matters of detail. It is scarcely worth while to take space to enlarge upon these. No machine was ever yet designed, that longer experience did not point out defects in it which were soon found remediable, if alone the *principles* upon which all was based were sound. These we believe are sound and good here; and the *residuum* of objections that are based upon the employment of the principles Mr. Fairlie has adopted, or that seem necessarily to cling to these, appear to us to be few. Perhaps two of the most cogent of these would take this form:—No railway can be insured to be a perfect plane upon the face of the rails, for even a few yards; it must be expected to have very often sudden hollows, twists, inequalities, within a few feet of each other; it will occasionally pass over culverts, level crossings, &c., where a short but positive *hump* may exist upon the line within a length less than that of one of those very long engines. The effect of these must be more or less seriously to strain and twist the entire system of such a long and flexible engine, and especially to derange the bearing surfaces of the engine, boiler, &c., upon the bogie frames, and with these all steam or other joints that have to pass from the boiler to the engine frames, through this shifting interspace. This is a matter only capable of being decided by the experience of rough and hard work, and then, if valid, to be met by improved arrangements in detail.

The other may be stated thus:—It may be admitted as a fact, that engines supported, as those of Mr. Fairlie are, upon bogie frames swivelling horizontally, round certain limits, and with all their wheels drivers, will be, while upon the rails, at least *as safe* upon a perfectly straight line of way (we believe safer), and upon any curve much safer, than engines of existing types. But yet it is conceivable that one or other of the bogie frames, most probably the leading one, and of that only the leading wheels, *might* by some means be thrown off the rails. In such an event it appears to us unquestionable that the tendency of the bogie, thus slewed over more or less as a whole, or with its leading wheels still urged forward in the new and abnormal path they had been forced into, must tend more rapidly and probably, to make the whole engine diverge still further, and either to turn over or to run quite off the line, and in certain places with terrible results probably.

This is, however, one of a class of questions upon which no true light can ever be thrown by discussion of generalities. There is but one method either of urging *à l'outrance* or of refuting the objection. Take a given design for an engine, with weights and dimensions, &c., all known; assume a certain derangement, as for example, the leading bogie thrown of the rails, and slewed to the maximum angle, the frame and connections will admit of, with the line of motion of the engine; determine the dynamic effort in the centre of gravity of the whole imposed system at a given speed, and deduce the moment of stability of the system, and those tending to derange its former line of motion. These are really questions of *how much* always, and it is because argued upon mere vague generalities, that we think some of the objections urged with much "war of words" against these engines would, if thus tested, perhaps disappear totally in validity, while others would at least show their genuine value, if any.

It is uphill work, however, attempting anything in the way of improvement in railway rolling stock, in Great Britain at least. The circumstantial difficulties due, to the pressure of traffic, of hard work on employés, and of finance upon Boards, &c., render even certain and assured advances slow and difficult; yet, in the end, what is genuine and right and sound, is sure to be *per force* adopted.

More recently Mr. Fairlie has applied his favourite principles in another form to a novel sort of locomotive for ascending steep gradients, such as that over Mont Cenis, wherein the weight of the passengers and their baggage are loaded upon the engine, so as to bring it in aid of adhesion. We must, however, reserve that to another article.—Ed.

VOELTER'S WOOD PULP MACHINE.

The increasing demand for all kinds of paper without a corresponding increase of the ordinary materials required for its manufacture, has led to a great number of attempts to employ other materials. From one cause or another the great majority of these attempts has been fruitless, with two exceptions, namely, straw and wood. Whilst, however, straw is largely employed in this country as a paper-making material, very little use has been made of wood, partly on account of the difficulty of reducing it to a suitable pulp, and partly on account of the possession by most woods of an amount of colour which it is not easy to get rid of. The latter obstacle may, to a certain extent, be avoided by employing only white wood, such as the aspen and the lime tree afford; but it is just this white wood which is least abundant with us, or the timber with that quality is valuable for other purposes. On the Continent, on the other hand, white-wooded trees abound, and there consequently the manufacture from wood of pulp suitable for paper is much more largely carried on than with us. In the Prussian section at the recent Paris Exhibition there were one or two exhibitors of paper pulp in small quantities. The only British exhibitor of wood pulp at Paris, so far as we have ascertained, was Mr. Burdon, of Teams, Gateshead; but whatever merits his specimens may possess, its strongly-marked yellow colour would unfit it for use where the manufacture of white paper is in view. Bleaching, it is true, is partially successful in removing the colour, but then it adds considerably to the expense of manufacture.

All materials proposed to be used in the manufacture of papermust be composed of fibres, and it is essential that they should not be injured, but only torn apart, in the process. Paper derives its firmness and substance from the interlacing of the fibres: if it was composed of ununited particles it would fall to pieces as soon as it was touched, and would be altogether unsuited for the purposes to which paper is applied. In preparing pulp from wood, therefore, it does not answer to employ saw-dust, because the fibres, or the majority of them, are already too short. M. Henry Voelter, of Heidenheim, in Wirtemberg, the inventor of the effective machinery we are about to describe, adopts the plan of pressing the wood against a revolving stone, by which means the fibres are torn off, and prepared for further reduction between a pair of millstones.

A separate house in the park round the Exibition building contained one of M. Voelter's machines at work, driven by a steam engine of 50 horse-power. The machine was made by Messrs. Decker Brothers, of Canstatt, from the designs of the inventor, who is himself a paper maker, and it attracted not only the general sight-seeing public, but a large number of paper manufacturers. The jury acknowledged the merit of the machine by bestowing a gold medal on the inventor, and they also gave him a silver medal for the specimens of paper he exhibited.

At one end of the house we saw the blocks of wood as they were brought in. The wood employed was aspen, but an experiment was to be made with beech. The blocks are first deprived of any pieces of bark that may remain attached to them, and then sawn across, and roughly split into pieces about 11 inches long by 1 thick. The knots must also be removed. The pieces are then hoisted up to the reducing machine, which consists of a revolving stone, against the circumference of which the wood is pressed by means of self-acting mechanism. This mechanism consists of five sets of iron blocks or holders, each retaining its quantum of wood against the circumference of the revolving stone, which should be driven at the rate of from 160 to 180 revolutions per minute. Pressure is conveyed to the wood holder by a spindle which bears upon a spiral spring lodged in the holder. Near the other end of the spindle is a toothed wheel, actuated by an endless screw, on another spindle placed at right angles to the former, and this is driven by a belt, the pulleys of the five sets of holding apparatus being at one side of the machine. The main spindle of each set can be at any time thrown out of action by simply loosening a clip, and by another simple contrivance the holder can then be lifted up for the purpose of introducing more wood beneath it. Whilst the rotating stone is engaged in tearing off the fibres, streams of water are directed upon it from above. The water, carrying with it the reduced wood, falls into a receptacle underneath the rotating stone, and thence flows into another receptacle containing a revolving drum of very coarse wirecloth. This separates all the coarse unreduced fibres, which are washed into a box placed to receive them. They are either thrown away, or sent when dry to the furnace of the engine. The sifted fibres then flow forward to a second receptacle containing another revolving drum of finer wirecloth, which performs the duty of separating the finer fibres from the coarser. The former are carried off by a lateral pipe to the rollers to be mentioned presently, whilst the latter are passed down to a couple of millstones, one revolving upon the other. Here the coarser fibres undergo trituration and reduction, and they are successively sifted by three revolving drums of wirecloth, the last one of which has 40,000 apertures on the square inch. Attached to each of these three drums is either one or a pair of wooden rollers, so arranged as to take up on their circumference that part of the pulp which does not pass through the wire drum, and when the adhering pulp arrives at a certain thickness on the drum it is scraped off by a projecting edge, and falls into a receptacle placed to catch it. The pulp adhering to the first set of rollers may either be employed for the coarser papers, or it may be passed again through the millstones, so as to receive further reduction, and fit it for the finer papers.

Different plans may be adopted to remove the water from the pulp, so as to fit it for carriage to a distance in case it is not made into paper in the same establishment. M. Voelter has invented a self-acting rolling press, which squeezes out from 50 to 60 per cent. of the water. The rest may be removed either by artificial heat or by simple exposure to the air. M. Voelter's press consists of four pairs of wooden rollers, between each pair of which the pulp is successively carried by an endless web of cloth. The inventor calculates upon obtaining a hundredweight of pulp in twenty-four hours for each five horse-power employed, and therefore an engine of 50 horse-power should produce half a ton of pulp in that time. Very fair paper is made by mixing 50 per cent. of wood pulp with rag pulp; and its suitability for printing purposes is shown by the specimen of clear impressions exhibited.

THE RICHARDSON PROCESS.

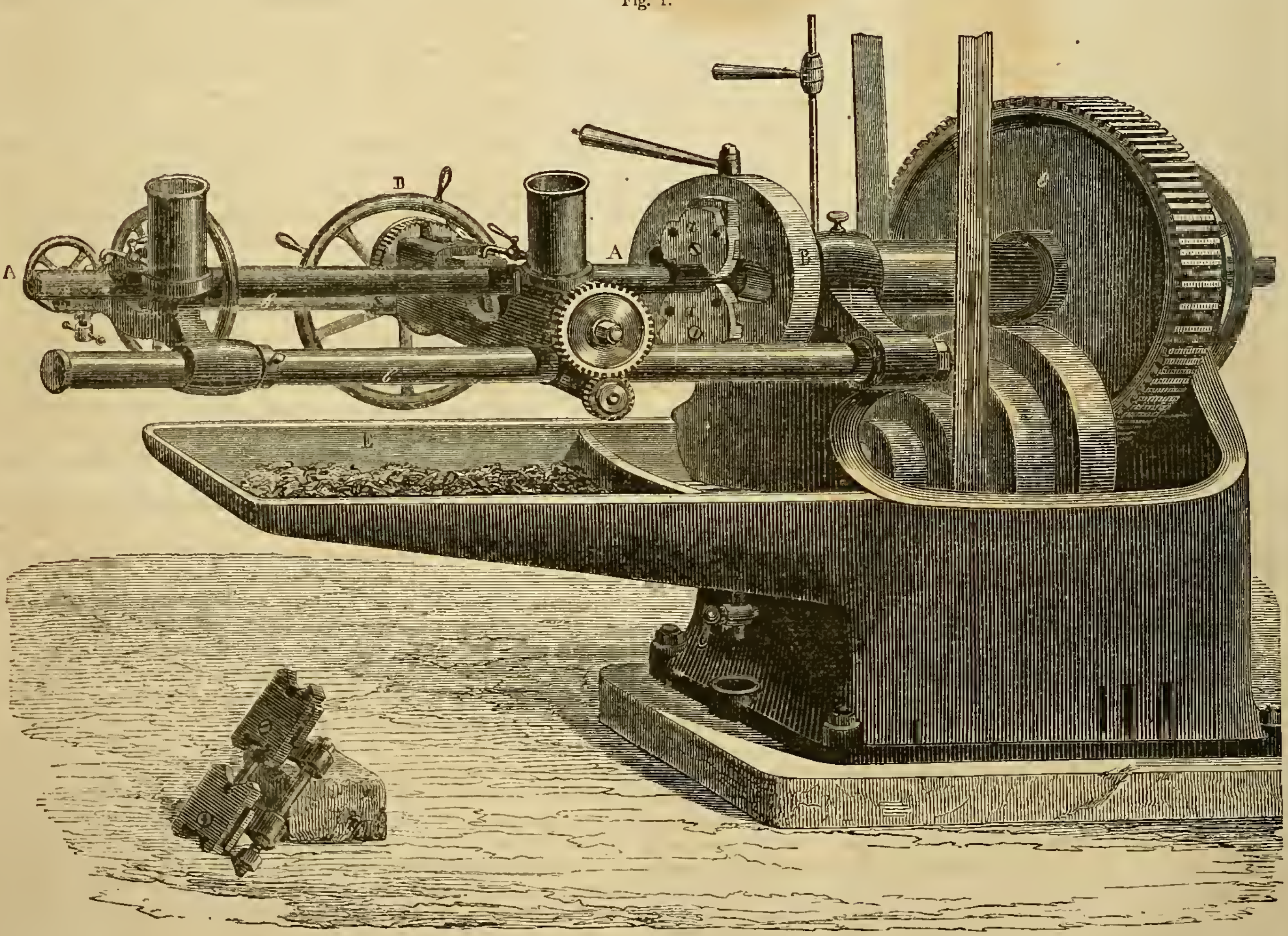
This method of manufacturing malleable iron is continuing to give as good results with the Cleveland iron as it was some months ago found to do with Scotch iron. At Parkhead, Mr. Beardmore is extending it to all the puddling furnaces as fast as the pipes from the blowing engine to the rabbles can be got in place; and during the last six weeks it has been put in operation at the works of Messrs. Palmer & Co. (Limited), at Jarrow-on-Tyne, as well as at the Whittington Ironworks—Messrs. Williams & Co. In both cases the improvement in the quality of the iron, as well as in the yield, is very marked.

It has been found at Parkhead that when making iron by this process, a less quantity of scrap is required, as the bottoms last much longer; not more than one half of the scrap formerly employed is now used.—V. D.

POULOT'S SCREW-CUTTING MACHINE.

The following is a description of the screw-cutting machine constructed by M. D. Poulot, a machine tool maker of Paris, who has given much attention to the subject of screw-cutting machinery.

Fig. 1.



The machine shown in fig. 1 is intended for use in engineering works, &c., and to be driven by steam power. It is capable of cutting screws and tapping holes of from 8 to 40 millimetres in diameter. The shaft of the machine is hollow throughout; it is thus capable of receiving bolts or rods to be screw-cut of any required length; the cut shows a tube, A A A, traversing the machine. On one end of the shaft a plate, B, is formed, which is intended to receive the clamps, *a a*, the distance between which may be adjusted at will to the form of the piece required to be secured in position; and behind the clamps a groove is provided for the passage of the pieces intended to be screw-cut.

Another shaft situated underneath the former is secured to the frame, and carries a stepped cone for the purpose of varying the speed. This cone carries a pinion cast in one piece with it, which transmits motion to a toothed wheel, *c*, mounted on the other shaft, the wheels being in the proportion of 1 to 5. The die-carrier is capable of motion in a longitudinal direction, and slides on guides, *b b*, which prevent any rotatory motion, the tightness of the dies being regulated by a hand wheel, D. The dies are secured to pieces of iron, and their distance from the centre of the machine is adjusted by means of two screws fixed to the carrier, one being right and the other left handed. These dies are formed of two ends of a bar of steel rolled to size, attached to the carrier by means of a screw, and so arranged that the carrier can be brought into proximity with the clamps, *a*, as shown in the detached piece of the figure. At the front of the machine a trough, E, is provided for the reception of the oil which lubricates the dies when at work, and the chips resulting therefrom. The whole falls on an inclined plane which admits of separating the oils from the chips, and the oil thus separated is withdrawn by the cock, *c*. The apparatus may be instantaneously stopped by the workmen in charge.

Fig. 2.

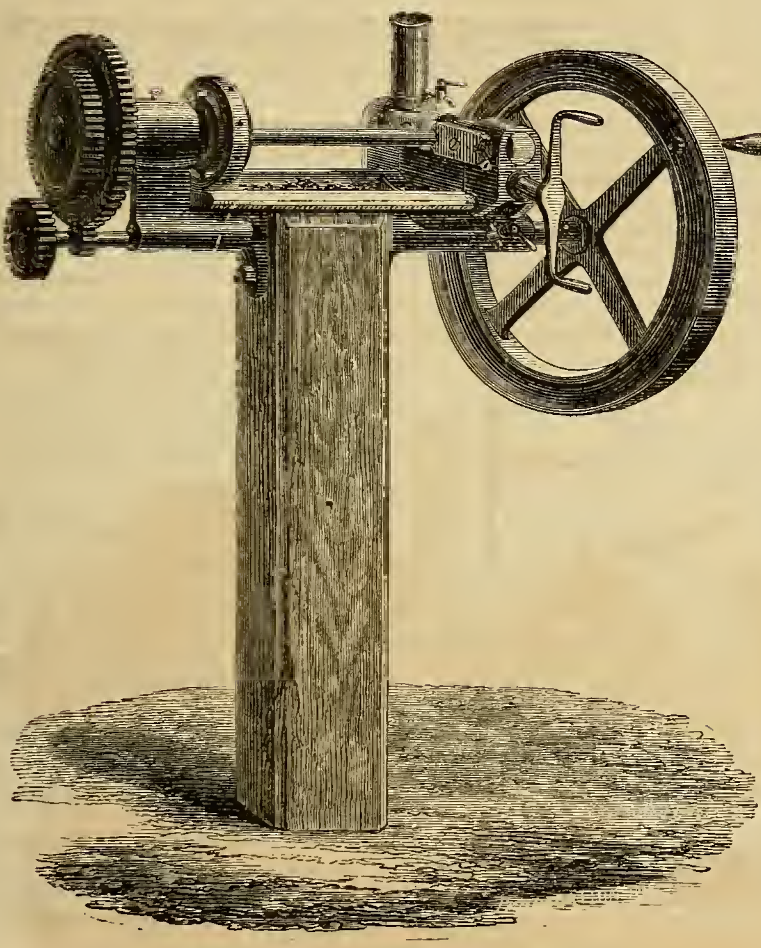


Fig. 2 shows another type of machine intended for use in other places where a smaller tool is required. This machine is constructed on the same principles as the other, and works by hand. It may be readily transported, and seems likely to be of great service in dockyards and in the mounting of metal structures, as the screws may be cut on the spot.

MR. KING'S APPARATUS FOR TESTING BARS AND THE THICKNESS OF PIPES.

Two very ingenious contrivances for the purposes mentioned in the title have recently been designed and brought into use in Glasgow by Mr. J. H. King, the representative here of the contractors of the Calcutta Waterworks. The bar tester has been made by Messrs. D. Y. Stewart & Co., the well-known pipe founders of that city.

Fig. 1 is an elevation, and fig. 2 is a section, of the testing machine. On the main spindle, S, on which the weight, T, is keyed, there are two threads cut: one near the centre, on which the hand wheel, M, runs, has six threads to the inch, and the other, near the top of the spindle, has five threads to the inch; on this thread the disc, C, works, for registering the deflection.

It will be noticed that the face of the disc, C, is shown in contact with that of the brass bush, B, through which the top of the spindle passes, and that the hand wheel, M, is against the face on which it works when the large weight is being lowered on the bar.

It will now be readily understood that in the position shown, if the hand wheel, M, is turned round one revolution from left to right (it being a right-hand thread), the spindle will be lowered $\frac{1}{6}$ of an inch, and, in the meantime, if the disc, C, had no motion communicated to it, there would now be $\frac{1}{6}$ of an inch of space between the face of the disc and the face of the bush; but if the hand wheel and the disc, C, are connected together in such a manner that when the one turns the other moves as well, but with freedom to slip if an obstacle present itself to stop such a motion, the disc will always be kept against the face of the bush; for while the spindle is sinking $\frac{1}{6}$ of an inch by one turn of the wheel, the tendency of the disc is to rise $\frac{1}{5}$ of an inch, which it would do were it not prevented by coming against the face of the bush. This connection is practically made by the tube, J, the lower portion of which fits into the hand wheel, and on the upper, above the collar, H, a short brass tube, E, is fitted, having a slit cut a part of the way down, which, when sprung over the smaller portion of the disc, forms a spring clip, possessing sufficient friction to move it round, but at the same time allowing it to slip easily when it comes in contact with the face of the bush; this, then, will always give the deflection correctly proportioned to the fall of the spindle, and it will be perfectly independent of the position of the hand wheel with regard to the face, N, which is variable, as will be seen afterwards, in lifting the upper weight. The amount of deflection is read off on the circumference of the disc, C, which is formed of a sliding brass ring, graduated into two equal parts of 100 divisions each, every division representing a fall in the spindle, or a deflection in the bar, of $\frac{1}{1000}$ of an inch; and at each semi-revolution of the ring a stud in it turns the small ratchet wheel above it round a tooth, which completes the registration of the deflection to three decimal places.

After the bar which is to be tested has been placed in its proper position, and the V-piece in the centre of the spindle just brought into contact with it, the disc, C, is brought up by hand against the face of the bush, B, and the graduated ring turned round till it is brought up to the zero point; the hand wheel is then turned round, and the whole of the lower weight is allowed to come on the bar, T. This weight, including spindle wheel and all other connections, weighs 700 lbs. (but can easily be made up to any dead-weight required), is allowed to come upon the bar. The 700 lbs. will seldom be found sufficient to cause fracture, and it then becomes necessary to bring additional weight into action. This is done by continuing to turn the hand wheel, M, till the three little steel rollers, which work in slots in the loose ring, L, come into contact with the under side of the weight, K, which, it will be observed, is supported by two spiral springs fastened to the angle irons, D D, at the side of the frame; and if this motion be continued and the bar be strong enough, the whole of the weight previously borne by the springs will be transmitted to the bar, giving a total testing weight of 950 lbs., as the small weight, K, weighs 250 lbs.; this range being found sufficient, with very few exceptions, for all tests required.

The proportion of the upper weight which is brought into service in breaking the bar is read off upon the scale, G, by the pointer, F: the deflection of a spring is always proportional to the amount of weight it has to bear.

The actions of the springs and graduations of the scale were verified by having two pulleys fitted into the frame, A, and two ropes attached to the weight by the pins, I I, passed over them, and dead weights, O O, hung on the other side, which, with a knowledge of the friction of the pulleys and the rope, easily determined beforehand, gives the best possible check to the scale; and it is very satisfactory to find that when this test is applied it accords exactly with previous anticipation. It is only necessary then to determine with accuracy the two extremes of the scale, at the one end by bringing the rollers just up to the weight as it hangs suspended by the springs, and at the other by slackening back the lock nuts under the angle irons, and screwing up the weight till it is seen there is no weight on the springs. If we now suppose the bar to break at any point, the spindle with all its connections will fall on the india-rubber washer, V, on the top of the bottom bush, and the deflections with which the bar broke at will remain recorded on the deflection disc, while the weight will be given by the pointer on the scale, so that both weight and deflection can be read at leisure after the bar is broken.

Fig. 1.

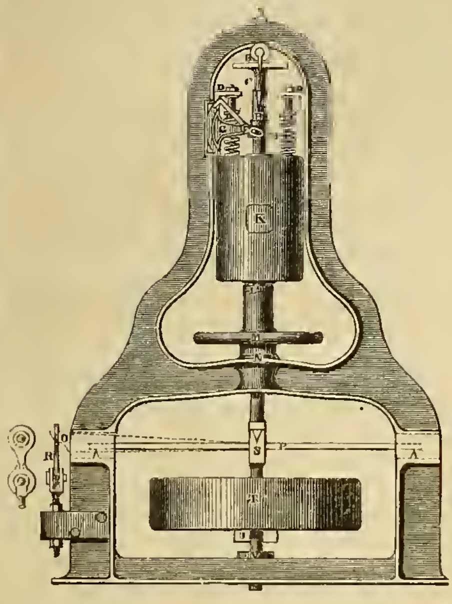


Fig. 2.

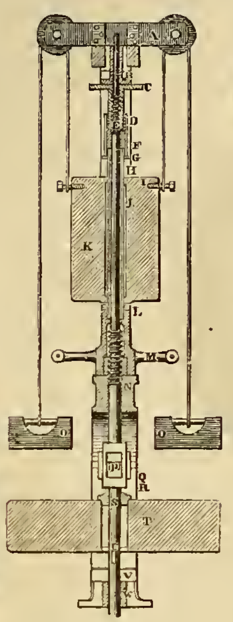
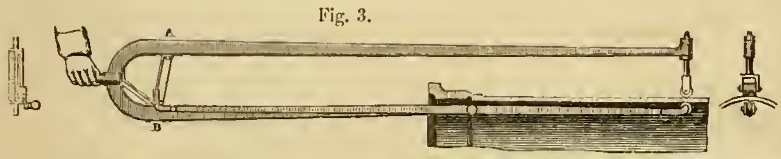
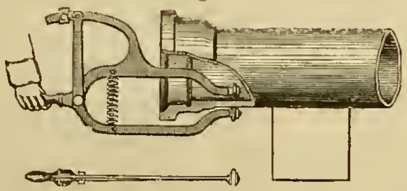


Fig. 3.



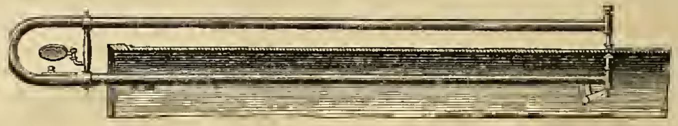
The short end of the pointer, F, is provided with a slot, into which is fitted a pin which, resting on the collar on the top of the tube, moves up with the weight; this provision being made to allow of an adjustment to suit any variations in the strengths of the springs, which will, no doubt, become weaker in time, although there is very little wear upon them, in consequence of their being relieved of all strain except when the bars are being broken.

Fig. 4.



It might be suggested that small dead-weights picked up one after the other by the hand wheel as it rose would act with more certainty than springs, but a little consideration will show that an error may be introduced in the breaking weight equal to the amount of one of these dead-weights. For instance, where an additional weight of 250 lbs. is required, this could be made up with ten 25-lb. weights, which would be quite as many as could be used with convenience; but here you might introduce an error of 25 lbs., for it might possibly be the last lb. of a weight which broke the bar, but it would not get credit for the 24 lbs. which it stood without breaking if the weights are not counted until they are clear of all support, and if this condition is complied with, it is easy to see that the weight which really breaks the bar is never lifted at all. Whereas, on the contrary, if the record is taken as soon as the surfaces of the two weights come into contact, the bars will be represented on the average as standing 12½ lbs. higher than they really did—this difference of reading, with the same weights and the same machine, making the average of bars read the one way higher than the other by the amount of the least weight used; but, independently of this, the gradual application of the weight, such as is given by the relief of the springs, must be preferable.

Fig 5.



The application of two spiral springs which might be put into tension by the hand wheel as it rose, would perhaps be a simpler arrangement than the present one; but the objection to springs used in this way is, that they become weaker in time, and there is no way of discovering an error, whereas a dead-weight suspended forms an unerring check which detects any variation at once, and enables a correction to be made. It may be mentioned that the little downward thrust produced by the pressure of the deflection disc against the brass bush, but which is very light, is considered to counterbalance the little friction which must exist in the spindle working in the top and bottom bushes.

The machine can also be used for testing the tensile strength of metals, by placing a steel lever on the V-piece, and making it the fulcrum; the short end of the lever passing through the frame, and the long one coming under the knife edge in the centre of the spindle. The link to be tested is fastened at the lower end by the pin slipped through the joint connected with the frame, and the other is slipped over the end of the lever. This arrangement being completed, sufficient weight is applied in the ordinary way to break it. With the present lever in use the minimum weight that can be applied is 2100 lbs., and the maximum 5700 lbs.; this variation being effected by shifting the centre of the lever on the fulcrum, making the ratio of the long and short ends 3 feet and 6 feet to 1 respectively.

The callipers have been expressly designed for testing the thickness of pipes. The long one, fig. 3, is adapted to measure the thickness of pipe 4 feet 6 inches in from the end, and the shorter one, fig. 4, gives the maximum and the minimum thickness at the spigot ends.

Upon the upper leg of the long callipers, fig. 3, and at the extreme end, a stud or pin is fitted, carrying a roller, which runs upon the top of the pipe; and on this stud a thread is cut, to allow of adjustment, by means of the nuts at the top and bottom of the boss through which it passes.

Upon the lower leg, which is about two-thirds the length of the upper one, a lever works upon a stud at the end. The shorter end of the lever is provided with a small roller, which is kept against the inside of the pipe by means of the longer end, by being of greater weight; and this end records the thickness of the pipe upon the vertical scale which is fitted between the two sides of the instrument, and likewise performs the office of a stay. In order to read this scale horizontally—which in practice is found necessary, to avoid stooping—when testing small pipes, a plate-glass mirror is fastened to the frame, at an angle of about 45 degrees, which, reflecting the vertical scale, enables it to be easily read by anybody standing above it.

It is hardly necessary to state that these callipers can *only* be used for trying the thickness at the top of the pipe; but practically there is little disadvantage in this, as the light side always comes to the top, if a pipe is rolled on a level surface, and it can easily be turned round and tested again, if desired.

The reason why the callipers give the thickness of the pipe only on the top is, that there is an error occasioned by its springing, which can only be corrected when held vertically. As long as it is held so, the error is constant. It can be taken into account, and the instrument adjusted accordingly; and if the person using it holds the handle at the extreme end, resting the large roller on the top of the pipe, and allowing the roller at the end of the lever to come against the inside of the pipe, it may be relied upon as giving an uniform result.

The scale is divided by passing the rollers over a carefully prepared iron scale, which is held horizontally in a vice; and the adjustment is easily done at the stud, on comparing the reading on the scale of the callipers with that on the iron scale, as the roller passes over the latter.

The other long pair of callipers, fig. 5, is a modification of the callipers first made by Mr. King. It is made of a wrought-iron tube, in which is carried the rod connecting the bell-crank with the scale that records the thickness of the pipe. The connecting rod is thus protected from injury, instead of being exposed, as in the first callipers made by Mr. King; and as the callipers are round, no handles are required, as in fig. 3—a magnifying glass is used to read the scale.

The small pair of callipers, fig. 4, are found to be useful in giving, at a glance, the minimum thickness at the end of a pipe—to try which they are opened by hand and slipped in it, the two small steel rollers being kept up by the spiral spring against the inside and outside surfaces. They are then run completely round the pipe, and, previous to being taken off, an examination is made of the slide on the scale, which is connected with one leg of the callipers, and which is pushed back by the arm on the other, as the surfaces of the two wheels, kept up by the spiral spring, come nearer together, until the minimum thickness is reached, the slide then remaining till it is read off. When put on another pipe the slide is pushed up by hand to the arm, and the process repeated as before.

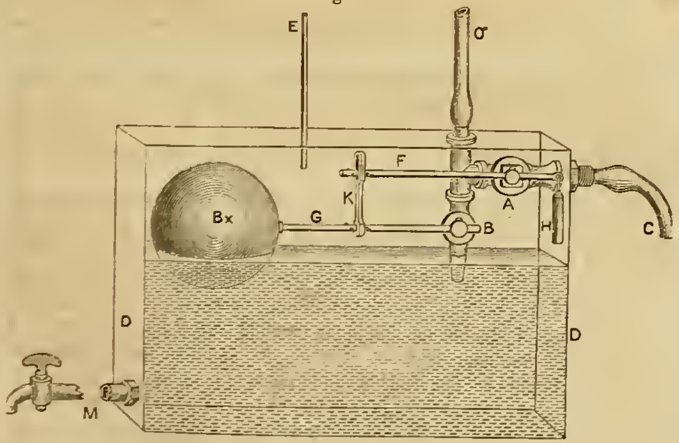
The ordinary mode of testing a pipe for thickness is to try it with the long callipers at the centre and spigot end, and afterwards run the small pair round the socket end, which shows the minimum thickness there; and if a pipe stand these tests it may be considered uniform throughout.

KIDD'S PATENT SAFETY APPARATUS FOR PREVENTING THE BURSTING OF WATER PIPES BY PRESSURE OR FROST.

SECOND NOTICE.

Since we noticed this apparatus in a previous part it has been rendered more simple in some of its details, and therefore less liable to the exceptions we before took to it. We described its action as being twofold; 1st, to cut off the supply where it enters the house, as soon as the house cisterns are full; and 2nd, to keep the pipes always empty, except when the water is actually running in them. We further stated that it was equally available whether the water supply was constant or intermittent.

Fig. 1.



In the more simple form the apparatus has now assumed all these objects are fully provided for, and the action is complete and automatic. We have still the two cocks, A and B, fig. 1, on the supply main, C, as near as may be to where it enters the house, and a small cistern or tank, D, placed underneath them, into which an overflow or notice pipe, E is conducted from the highest house cistern. This regulating tank or cistern is of cast iron, of about the same dimensions as the cisterns used for regulating the supply of water to kitchen-range boilers; it is 22 inches long, 14 deep, and 8 wide. The supply main from the street is brought through an opening at one end of this cistern, and has the stop-cock, A, placed on it there. One of Guest & Chrimes' screw-down ball-cocks, or some other form of high-pressure cock, may be used here. The exit end of this cock is connected by means of a T-shaped junction with the rising main, O, and with a two-way ground plug cock, B, of which fig. 2 shows a section. This cock, B, is connected by a lever rod, G, with a copper ball, B′, which is 6 inches in diameter. The cock, A, has also a lever rod, F, which at one end carries a weight, H, and at the other is connected by means of a link, K, with the lever rod, G, of cock B. Fig. 3 is a front view of this link, and shows a slot through which the lever, F, passes. Pins passed through the lever rods, G and F, on each side of the link keep it in its place. M is a pipe leading from the regulating tank, and closed by an ordinary bib-cock. This pipe may be conducted to any distance, or have any number of branches; and all the water used in the basement story, either in the kitchen or scullery, in the boiler or in the servants' water-closet, is obtained through this pipe, M, or its branches.

Fig. 2 shows a section of cock B. The apertures are so placed that when the tank, D, is full, and the ball raised, there is a free passage for any water there may be in the rising main, O, to escape into the tank; but when the ball is in this position the stop-cock, A, is closed, and no water enters, and none can escape but that lying in the pipes. On the other hand, when the tank, D, is empty, and the ball falls, the cock, A, opens, and the cock, B, also opens by virtue of the second way, and a continuous stream passes from the main into the tank D, and thence through M, if it be open, affording a supply direct from the main for kitchen and other purposes. As soon as sufficient water has been obtained, and M is closed, the tank D begins to fill, and the ball rises sufficiently to close the cock B, but, in virtue of the play room afforded by the slot in the link, K, does not affect the cock A, which still remains open; and now the water passes through the rising main till it fills the house cisterns, when the overflow comes down by the pipe E, and filling the tank, raises the ball till it closes the cock A and opens the cock B, when the pipes empty themselves. Thus the whole action is automatic, and requires no attention or knowledge of the process on the part of the servants; and as no water can be obtained on the basement story except through M or its branches, the house cisterns are filled every time water is drawn in the basement story, and are kept full without special attention. The weight, H, prevents the cock A being opened by the pressure of the water when the weight of the ball, B′, is taken off it, and also closes the cock slowly and gradually.

Fig. 2.

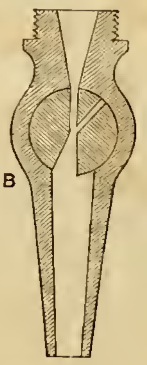
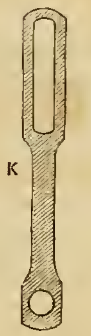


Fig. 3.



When the supply is only afforded during certain hours in the day, there need not be two channels through the cock B, as it is only necessary to have it open when A has been closed. In this case there should be a cistern in the basement story sufficiently large to hold a day's supply of water, and the regulating tank, D, should be placed immediately above this large cistern. A branch must be taken from the rising main, O, for the supply of this cistern, and have an ordinary ball-cock on it. The pipe, M, must be permanently open, and be of such a size that it will take the tank, D, some time to empty itself. It may discharge into the large cistern. As soon as the water is turned on in the street it will pass the cock, A, into the rising main, and thence through the branch to the large cistern. As soon as the cistern is full the ball-cock placed on it closes, and the water rises to the cisterns on the upper stories, filling them in succession; and when the highest is filled, the overflow comes down and fills the tank D, raises the ball B′, closes the cock A, cutting off the supply, and opens the cock B, so as to empty the pipes. The tank, D, now empties itself slowly and gradually, and by the time the supply is turned on again the ball has fallen, the cock, A, is open and B is closed, so that the water can enter the house till all the cisterns are filled.

With either a constant or intermittent supply, it is desirable to do away with distribution pipes altogether by placing small cisterns, served with branches from the rising main, wherever a supply may be required, and allowing the water to be drawn from them direct. Thus the injury done by the reaction from the sudden stoppage of a current through the pipes, to which we alluded in our former notice, will be entirely prevented, and all the pipes will be kept empty except when the water is actually running. The apparatus, as it now stands, is certainly one of practical utility, and one which we shall be surprised should it not be brought extensively into use.

BEHRENS' DUROMETER.

M. Behrens, an engineer at Tarbes, in France, sent to the French Exhibition a specimen of his Durometer, an instrument invented by him for testing the hardness of metals, and which was stated to be employed extensively in France and Germany for that purpose. He has communicated to us some notes on the subject, from which the following description has been prepared.

The first testing apparatus was constructed at the Seraing Iron Works in Belgium, with the view of ascertaining the hardness of rails for railways. It was made on the principle of drilling a hole with a two-edged tool, about 10 millimetres wide, loaded with 10 kilogrammes, in the rail to be tested, and in a bar of rolled cast steel from the works of Petin, Gandet, & Co., the latter being used as a standard. The depth of the hole made by the drill, which was turned by a wheel and handle, was measured in hundredths of millimetres, a dial face indicating the corresponding number of revolutions of the wheel, and the depths were registered in a book at every 50, 100, 150, or 200 turns. The depth drilled being assumed in the inverse ratio of the hardness, it follows that the relative hardness of the rail to the cast steel will be in the proportion of the length of hole drilled in the steel, divided by that drilled in the iron. This first instrument answered but very imperfectly; the amount of penetration diminished with the depth for the same number of turns, and it appeared inapplicable from defects in its construction. Another apparatus was then made, under the directions of the inventor, by M. Gustave Froment, who constructed it with the greatest possible care, and with all the requisite appliances for the accurate observation and measurement of the depth, and for the registration of the number of turns; but this was also found to be similarly defective. A consideration of the causes which might influence the diminution in the depth drilled for the same number of turns, led M. Behrens to the conclusion that it was due to the resistance to the drill of the detached cuttings, and also to the difficulty of centering by sharpening the edges of the two sides of the drill of the common form. M. Froment concurring in this opinion, he was led to construct a preparatory tool, isolating the cylinder, of 10 millimetres, and boring at the same time a central hole 3 millimetres in diameter. The result is stated to have fully realized their expectations, and the durometer has become since 1859 a practical instrument for testing the hardness of rails. The durometer as constructed by M. Froment may be described generally as an upright cast-iron standard, bolted down upon a bedplate, and provided with a table for supporting the rail, or article to be tested. The spindle of the drilling tool is capable of being raised and lowered in its bearings by turning a handle for that purpose, and the drill is held down to its mark by a weight fitted to the upper end of the drilling spindle. It derives its rotatory motion by the aid of a pair of mitre wheels from a driving shaft carrying the usual fast and loose driving pulleys. This shaft has a worm cut upon it, which actuates a train of mechanism in connection with a signal gong, for the purpose of indicating the number of revolutions made by the drill. The apparatus is exceedingly compact, standing on a foundation plate of about 16 inches by 14, and being about 3 feet in height. It is stated that it is frequently a condition in French contracts for rails that they are to be tested by this apparatus.

This instrument, too, is reported to have shown that the rails treated by Dodd's cementation process are increased in hardness about 33 per cent., and are made superficially equal in hardness to those of rolled cast steel; so that M. Behrens has been enabled to lay the incline from Pistoia to Bracchia with rails which during the three years they have been in use have exhibited almost no signs of wear, notwithstanding the immense weight of the eight-wheeled Bengnot engines employed on the line, and the friction caused by the frequent use of the brake. It has only been requisite to change three rails during that time, and this was owing to defects in the welding. In Germany the engineers of the various lines, having seen the excellent results obtained at the Ruhrort Iron Works, are stated to make testing with the durometer a condition in their contracts, and French iron manufacturers rely on the durometer for ascertaining what are the best mixtures of ores, where hardness is a principal object; and the employment of this instrument has led to a gradual increase of hardness in the rails they produce.

FLAMM'S MECHANICAL TYPE-COMPOSER.

We are indebted to a French source for the following account of a new type-composer, characterized by considerable ingenuity, and one that promises to be useful for certain special purposes.

It is requisite to see all the details which compose the apparatus of a printing office, the incalculable amount of stock in the shape of type, lead, forms, composing sticks, galleys, slabs, imposing stones, boxes, &c., to enable one to form an idea of the extent of capital required by a printer. At any rate a complete assortment of characters representing a value of from 50,000 to 100,000 francs is required; for those types which are set up are frequently unavailable for several days whilst awaiting corrections, or until a sufficient number of proofs have been struck off; and by reason of the crushing of the type under the press, or of the granulation of their faces by being impressed on paper of inferior quality containing in its pulp grains of sand or other hard bodies, or by the cleaning with a hard brush after working off, they rapidly wear out, and there remains nothing more than the value of the metal; they have therefore to be renewed at the end of two or three years, which is a loss to be carried to the working expenses. The "forms" after cleaning have to be decomposed, which operation is called *distribution*, and occupies rather less time than the *composition*, and as this is intrusted to the apprentices, a bad distribution is the source of the typographical errors in future compositions, for even the most adept sometimes throw the letter *n* into the box for the *u*, *V* into that of *A*, and confound *d* with *p b q*, and so for other letters, or else reverse them in the composing stick; the smallest foreign body interposed between the letters, or at the bottom of the form wedged in under the press produces uneven lines, letters too high or too low, all which defects necessitate four or five corrections, besides the overrunning of the type on the imposing stone.

To find a means, then, of departing from this beaten track of four centuries appeared, if not an unsolvable problem, at any rate one beset with great difficulties. M. Flamm has, however, effected its solution, but instead of basing himself on the Gutenberg system he has entirely abandoned it, and attains to the same end by simpler means. By his mechanical composer, patented in France and abroad, he dispenses with all this costly material; he only requires a single alphabet for each kind of type, and as many varieties of type as of complete cases, to compose any text required. The type is contained in a reservoir which is pivoted so as to turn round on its axis, and indications corresponding to each of the letters are made on the rim of a manipulating wheel; it is only required to bring one of the signs on the wheel opposite to a fixed mark, and the required letter appears under the pressing surface; this is the only place in the reservoir where the type can impress its face on the surface below, and this is effected with an incredible facility and rapidity; a sliding matrix is moved at will transversely and longitudinally under the reservoir, the first motion forming the lines and the second the ranging in order to obtain the pages; on this slide there is disposed a plastic pulp suitable to receive and preserve the impressions obtained from the different types.

In order to commence any line this slide is moved by means of a screw, and it carries with it an adjusting hand which indicates on a graduated scale the distance traversed by the slide. On the arrival of the hand at the margin of the page to be formed, the wheel is turned to the right hand to bring any required letter opposite to the fixed mark, and by drawing an actuating lever to the left hand the letter is depressed, imprints its face in the pulp, and rebounds to its original position. The slide is then moved in a similar manner for the impression of a second letter and so on for all the letters of the line. The operator proceeds thus with its formation until a bell warns him to finish a line, when the justifying operation commences, which presents no difficulty; for as the operator becomes more and more adept, he learns to stop somewhat near the end of the line, he marks on the dial the point to which the indicating hand has arrived, fixes the pressing surface, and continues the composition as if the type were working. On arriving at the end of the line it may come out exactly, or he may be a few points out either way, of which he will take account in order to distribute the difference either among the spaces between the words being composed or between the letters of a word; for as soon as it is known, the operator throws the pressing surface into gear, touches a button, which instantaneously changes the direction of the slide from left to right, and moves it so that the hand exactly indicates the end of the line, and composes the reverse way the words which are to form part of the line to be finished.

The leading is produced by turning a graduated disc, admitting of differences of the 64th part of a French line, which causes the slide under the pressing surface to move longitudinally either forward or backward as required. It is evident that great facility is afforded for using all the letters as upper or lower letters, by which the most complicated algebraical formulæ, tables, &c., may be composed with great rapidity. For this purpose M. Flamm does not depend upon the operations of the adjusting hand, but has added to the outside of the slide a table performing the same motions, on which is placed a piece of paper; a needle makes a prick-mark thereon for each character impressed, so that the operator can ascertain at any time at what position he is arrived, and this table is substituted for the operations of the adjusting hand when difficult adjustments are to be effected.

When the page is finished the matrix, containing impressions of the greatest clearness, is removed, and about a quarter of an hour is sufficient to dry it and take casts from it in the ordinary way. The corrections do not present any obstacle, for the pulp retains its plasticity for a long time. A faulty line or phrase, or word, must be effaced, and recomposed by replacing the plate on the slide.

When it is required to compose without producing moulds or casts the pulp may be replaced by a piece of transfer paper, over which is laid a sheet of unsized tissue paper, one side of which is thinly coated with thick greasy ink, and on which the impressions are effected in the same way as described for the pulp, the faces of the type making clear black imprints on the transfer paper. The corrections are made by cutting out the faulty words, which are recomposed on another sheet of paper. In order to work off these compositions it is sufficient to transfer to a plate of zinc, copper, steel, or glass, which are transformed with facility into printing surfaces by biting by acids in the well known manner. This latter method is more especially adapted to the production of cheap books and journals. When the proof obtained is transferred to stone, a print of admirable clearness is obtained at a very cheap rate.

Some conception may be formed of the ingenuity required to devise a means of effecting the regular spacing of all type without the aid of the operator, when we consider that all the letters vary in width, for the "W" requires more space than the "I," and yet this space, however varied it may be, is produced automatically with the most scrupulous regularity; everything is provided for in this apparatus, and if it is required to increase the distance between any letters or figures, in order to fill up a space, this is easily effected and with the greatest accuracy by the simple motion of a small lever.

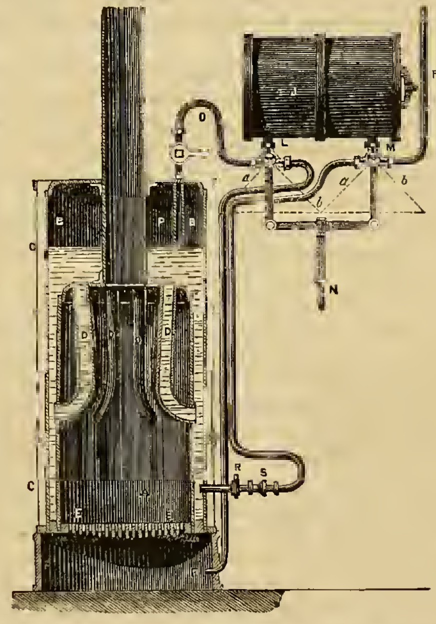
It will also be perceived that the faces of the type being inked by the interposition of a sheet of thin paper uniformly covered with a coating of thick ink, they are protected from dirt and constantly retain their original cleanliness, and the wear of the type is very slight, since its face strikes perpendicularly on smooth and soft surfaces.

The apparatus is portable, and combines both elegance and strength; its advantages are—saving in time and material, dispensing with the distribution of the type after the working off, the facility of composing in oriental and other foreign languages according to the description of type in the reservoir, and a diminution in the number of corrections. It is suitable for typographical printers, lithographers, missionaries, for the army, and is even adapted to the printing of telegrams with thick ink on metallic paper.

It is well known that a plastic material is displaced by the insertion of any solid body, and as the faces of the type are successively imprinted in the movable pulp, means had to be devised to prevent the impression of one letter obliterating that of another by its side. Similar difficulties had to be overcome in obviating the direct inking by the interposition of a sheet of inked paper between the type and the transfer paper, without the ink spotting the latter. The depth of the impression produced in the mould may be varied at pleasure, by elevating or lowering the table by means of a screw.

EGROT'S VERTICAL BOILER.

The following is a detailed description of the boiler used by M. Egrot with his steam-cooking apparatus, and which is also applicable to other purposes:—B is the boiler, A the furnace, which admits of being readily removed for repair; D a number of vertical copper tubes, conical in form, with the larger diameter at the base; E the grate; F a cast-iron support; G is a jacket enveloping the boiler, the object of which is to prevent loss of heat; J is the feed cistern, which receives waste steam from the boiler through the pipes, P, O, and feeds the boiler through the pipe and cock, R; the valve, S, prevents its return to the cistern. The water is maintained at a constant level in the boiler by means of the pipe, P. T is the pipe for escape of steam and admission of air to the cistern; L and M are three-way cocks, the former of which regulates the admission of steam to the cistern and its exit, and the latter the admission of water to the cistern and its supply to the boiler. These two cocks answer the purpose of the four cocks ordinarily used, viz., the air-cock, the cock for regulating the supply of water to the cistern, the steam-pressure cock, and the boiler feed cock. The cocks, L and M, are actuated by turning the handle, N, and with it the jointed levers connected therewith to the positions indicated by the dotted lines, *a* and *b*, respectively.



This arrangement is to be commended on the ground of its simplicity, and for the facility with which it may be applied to all the various purposes for which steam or heat is required. There is nothing new in this boiler, as far as this country is concerned; in fact, the barrel, tubes, and altogether a far better boiler, on the same principle of construction, was patented some time since by Mr. Andrew Barclay, of Kilmarnock.

THE EXTENSION OF THE RHENISH RAILWAY. THE STEAM FERRY FOR RAILWAY TRAINS OVER THE RHINE AT DUISBURG.

By Herr Emil Hartwich, C.E.

(*Illustrated by Plate* 1.)

Our Plate of this month illustrates the structural plan and details of this very successful Railway Steam Ferry, which has now been some time in constant use.

The great difficulties and heavy expenses which are usually connected with the construction of bridges over large rivers, as well as other obstacles in the way of such projects, to which especially belongs the supposition that railway bridges may be disadvantageous to strategical operations of defence, have produced the necessity to construct ferry-boats for railway carriages. Several of these have been constructed and brought into use with great success within the last few years, on the Rhenish Railway over the river Rhine, one of which, at Rheinhausen near Duisburg, we here illustrate. The oldest ferry-boat for railway purposes is, as far as is known, that over the Firth of Forth, near Edinburgh, from Granton to Burntisland, a description of which will be found in the minutes of Proceedings of the Institution of Civil Engineers, Vol. XX. Other ferries are between Homberg and Ruhrort, over the Rhine, and near Lauenburg, over the Elbe; also one which connects the Niederländische Rheinbahn with the Rhenish Railway at Griethausen, near Cleves.

The latter is constructed on the same principle as those English steam ferries at Portsmouth and Southampton. After different experiments with other systems had been tried, and after, instead of the heavy chains, lighter wire ropes had been introduced, the ferry-boat has been constructed on the Osterath-Essener Railway at Rheinhausen, near Duisburg.

The Osterath-Essener Railway has chiefly for its object to connect the entire system of the Rhenish Railway on the left bank of the Rhine, with the numerous coal mines and large iron mills on the other or right bank, near Essen. The construction of a fixed railway-bridge, as proposed by the Rhenish Railway Company, it was found would not be sanctioned by the Prussian government for strategic reasons. The Rhine has here a width of 160 ruthen = 1920 feet Rhenish; the difference between the lowest and the highest water-level is 25 feet, and the velocity varies from 3½ to 7 feet per second, according to the level and volume of the water current. The length of the ferry-boats is 160 feet, giving room for eight goods wagons of 20 feet each; and as the traffic chiefly consists in coal, a weight of 2400 cwts. is to be provided for. The wagons being drawn on or from the boats by the locomotive, the incline from the ferry-boats to the station has been fixed at 1 in 48. The distance between two lines of rails on the inclines had been taken as 72 feet, and the number of lines as five; but after the carrying out of the 2-feet inclines, a distance of 60 feet between the lines of rails was found sufficient, so that afterwards six instead of five inclines, and therefore also six ferry-boats, could be worked on the same space. Each ferry-boat is fitted with a steam-engine of 25 horse-power. Two wire ropes, one above the other, at right angles to the stream, and reaching from the highest watermark on one side, to the highest watermark on the other side of the river, are used for the propulsion and guidance of these boats.

The upper rope, 1¾ inch diameter, and running over rollers on both sides of the river, has its ends connected to counterbalance weights, which hang in wells, and produce a strain of 300 cwts. upon the rope. This upper rope is used to *guide* the ferry-boat only, and is secured to its position by anchor ropes, or water guys, at distances of every 120 feet. The distance between the upper and the lower rope is 26 feet, and the diameter of the lower one is 1⅛ inch; it has also counterbalance weights on both ends, similar to those of the upper rope, but these weights produce only a strain of 80 cwts. upon this rope. This rope is used for the propulsion of the boat. As already stated, each boat, the construction of which will be easily understood from the engravings is of iron, 160 feet long and 25 feet wide, and is plated under the water with ¼ inch, above the water with ⅛ inch, iron plates. In order to facilitate the junction between the line of rails on the boats and that on the incline, a very moderate height of the boats above the water was necessary, and that was fixed at 3 feet 6 inches, thus requiring a water-tight deck for the boats. For the more convenient junction of the boats and inclines of the lines of rails an intermediate movable carriage is used, which has, in order to reduce its length, an inclination of 1 in 12, but reduced to 1 in 16 at both ends, so as to prevent any dislocation of the chains or buffers of the carriages, while passing from this intermediate carriage on to the ferry-boat itself. This intermediate carriage has four axles with wheels of corresponding heights or diameters, and is constructed in such a manner as to produce a safe connection with the boats, without giving to the departure of the latter the least difficulty. The strong connections contrived between the boats and this intermediate carriage prevent any fluctuations or oscillations of the former, when the loaded or empty wagons are passing from the incline on to the ferry, or the reverse. After the ferry-boats are secured to the movable inclines, passenger carriages with the passengers inside may be drawn on to and off from these boats with perfect safety. Notwithstanding the strong construction of the intermediate carriage or movable incline, and the boats, and although they can carry locomotives, it is not found advisable, if practicable, to run the engines direct or alone over the intermediate carriage, but two empty wagons are attached to the engine and tender, and to these the other loaded wagons are coupled, so that the empty wagons are on the intermediate carriage, when the loaded wagons are on the ferry-boats, and the engine on the incline. For the propulsion of the boat there is employed, as shown in the engravings, a double-cylinder steam-engine, which drives through a train of wheel gear a rope pulley of 8 feet diameter. Round this pulley, and a corresponding loose one, is placed the wire rope of 1⅛ inch diameter, with 80 cwts. strain. With this strain the movement of the boat is very easy and safe, and there is sufficient power to drive two boats with one engine.

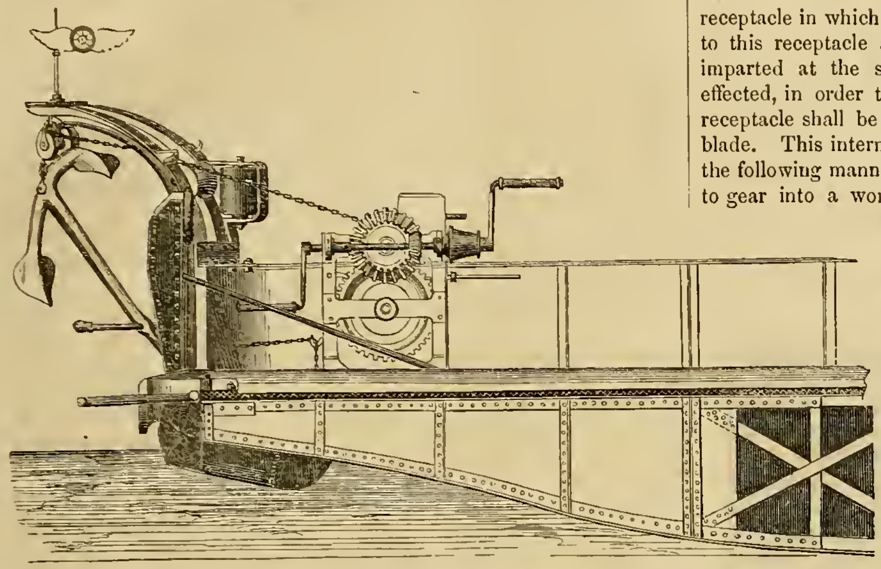
One great difficulty met with is to resist the current power of the river acting, broadside on, against the long boat, and so to perform the journey in that direct manner, and by the shortest line. The difference of the depth of the water has here to be taken into consideration, as everything depends on the right fixing as to position of the wire ropes or chains; for the working of the boat is only possible if the ropes or chains are fixed at such distances as are necessarily determined by the corresponding depth of the water, and velocity of current due to that. The heavy strain on the wire rope prevents any danger of its slipping off the rollers, and thus the drifting down stream of the boat is obviated, and the traject takes place quickly and safely. Notwithstanding the engine power would be competent to accomplish the passage in a very short time, it has been found desirable not to increase the velocity over 6 feet per second.

The steam ferry at Rheinhausen has proved that each ferry-boat in twelve hours can convey 150 wagons in each direction, whence one locomotive at each side of the water is sufficient to serve for two inclines or two ferry-boats. With night services one ferry-boat would be able to convey 300 wagons in twenty-four hours. According to the experience had, high water and stormy weather have no influence on the service, and even a slight drifting of floating ice did not interrupt the traffic. The perpetual vibrations and motions of the wire ropes prevent any formation of ground ice which might form in very severe winters, and into the inside of the boats steam may be brought easily from the boiler, were it found necessary, so as to keep the boats themselves free from ice exteriorly. The entire service of the boats is especially simple. As a crew to each boat belong only the captain, two sailors, an engine-driver, and fireman. Experience has, so far as the end of last year, not indicated any source of expenses in the repairs of damage to the ropes or parts of the machinery, and the working expenses altogether are so low that the whole arrangement has proved entirely successful, and better financially than any other work of equal capital ever carried out on the same lines of railway. With regard to the expenses for the construction of these steam ferry-boats at Rheinhausen, we give in the following the estimate as given by the chief engineer of the line, Herr Hartwich, for one ferry-boat and two inclines, viz., one on each side of the water:—

The anchor lines or moorings for all ferry-boats,	1,962	thalers	...	£294	0	0
Construction of two inclines,	23,789	"	...	3,568	7	0
The two towing and guiding wire ropes with anchors, &c., and guide-rollers,	5,940	"	...	881	0	0
Intermediate carriages or movable inclines,	9,816	"	...	1,472	8	0
Complete ferry-boat and power,	28,453	"	...	4,268	0	0
Extra expenses,	40	"	...	6	0	0
	70,000	"	...	10,490	0	0

In this estimate are not included the expenses produced by connecting the previously existing station on the lines of rails with the inclines, as these expenses will be different in different localities. The cost for the construction of the two inclines has been very heavy at Rheinhausen, as in consequence of a very high state of the Rhine and great depth of the water at the time of construction, a part of the work had to be done by divers, which increased the expenses considerably, and a steam ferry on the same principle should therefore under other circumstances be built at a much lower price.

It is not necessary to enter into any detailed explanation of the construction of the frame of the ferry-boat or of the machinery, as these will be clearly understood by the practical engineer from our Plate. The woodcut (fig. 1) shows some detail of the mooring gear at the extremity of the boat, which could not be embraced in the Plate, the length of the boat precluding the ends being shown.



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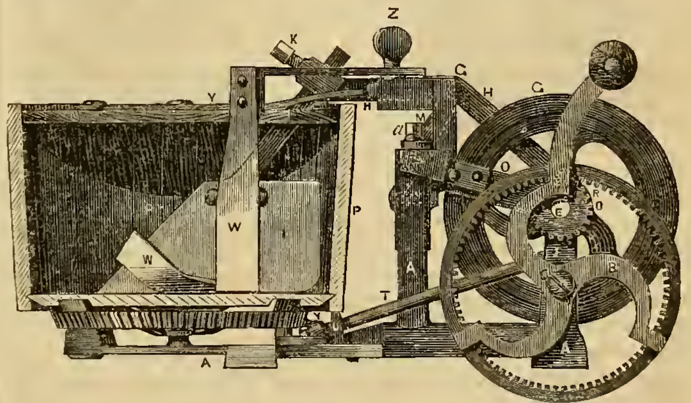
RECENT PATENTS.

MINCING MACHINE.

J. H. Johnson, *London and Glasgow.* — *A Communication from* David Lyman, *of Middlefield, Connecticut, U.S.A.—Patent dated 12th July*, 1867.

This invention relates to improvements in machinery or apparatus for mincing, cutting, or chopping meat, vegetables, and other like substances, whereby a great saving of time is effected, and the operation is more easily performed than when the ordinary methods are employed. The principal feature of novelty of this invention consists in giving to the cutter or chopper a chopping and a draw-cut motion, whilst the tub or receptacle used in connection with such peculiarly acting cutter or chopper, in which the substances to be operated upon are placed, receives an intermittent or a continuous rotatory motion.

The engraving represents a front elevation of the improved mincing machine. A is the framing of the machine; B is a band wheel carried by the stud centre, C. This wheel is provided with internal teeth, into which is made to gear the spur pinion, D, keyed on one end of the shaft or spindle, E, working in bearings, F, in the framing of the machine; the other end of the shaft carrying the fly wheel, G. H is a lever, which carries at one end the chopper or cutting blade, I, which is attached to the lever by the set screw, K. The opposite end of the lever, H, is connected to the fly wheel, G, by the crank pin, L, and is also connected at G′ to a short rocking lever, M, fitted to oscillate or rock on the centre, N, on the lever or arm, O, which latter is carried loosely, and is free to turn on the shaft or spindle, E. By imparting a rotatory motion to the fly wheel, G, by means of the toothed hand wheel, B, and pinion, D, an up and down, as well as a to and fro or draw-cutting motion, will be imparted to the cutting blade, I, by causing the lever to which the cutting blade is attached to oscillate on the centre, G′, and at the same time cause the lever, M, to oscillate on the centre, N. This draw-cutting action effects in a better and quicker manner the cutting of the substances than when a chopping action only is employed. P is the receptacle in which the substances to be operated upon are placed, and to this receptacle a continuous or an intermittent rotatory motion is imparted at the same time that the cutting of the substances is effected, in order that the whole of the substances contained in the receptacle shall be brought under the action of the chopper or cutting blade. This intermittent or continuous rotatory motion is obtained in the following manner:—R is a worm fitted on the spindle, E, and made to gear into a worm wheel carried on the upper end of the inclined spindle, T, working in bearings, U. This inclined spindle carries at its lower end a bevel pinion, V, which is made to gear into the bevel wheel, Q, to which the receptacle, P, is attached. In order to obtain an intermittent motion of the receptacle, P, the worm, R, is constructed with a thread or spiral, which extends only once round the spindle, so that it is made to gear with or act on the worm wheel, S, during only one-half of its revolution, the receptacle remaining stationary during the remaining half of the revolution of the worm. The worm is so arranged on the spindle, E, as that the dwell of the receptacle shall take place at the time that the cutter is making its draw cut. By constructing the worm with a thread extending once and a half or twice round the spindle, a continuous rotatory motion of the receptacle may be obtained. W is a stationary guide or scraper, which is made to bear against the internal circumference and bottom of the receptacle, and is twisted or formed in such a manner as that it shall cause the substances being operated on to be subjected to the action of the chopper or cutting blade, by throwing the substances over, after the manner of a ploughshare, as the receptacle revolves. The stem of this scraper is fitted into a socket formed in the bracket, X, fitted to or formed on the lever, *o*. The bracket, X, also carries the stem of the lid or cover, Y, which is firmly secured to the bracket by the set screw, Z. This lid or cover is provided for the purpose of excluding dirt, and also to prevent the substance when being operated upon from being thrown from the receptacle. An opening or slot is made in the cover to admit of the free action of the cutter, an opening being also provided in the cover for the stem or guide of the scraper to pass through. It will be observed on referring to the drawings, that the guide, W, cover, Y, and lever, H, carrying the cutter, are all connected to the lever, O, and this lever being free to turn on the shaft or spindle, E, may be elevated or turned back, in order to allow of the receptacle being removed when the substance contained therein has been sufficiently operated upon. *a* is a catch or button for holding the lever, O, and the parts connected thereto in position when effecting the chopping operation; *b* is a projection formed on the lever, O, for the tail, *c*, of the lever, M, to bear against, and to serve as a guide to insure the proper action of the cutter.



HYDRAULIC LIFTS.

J. HENRY JOHNSON, *London and Glasgow.—A Communication from* ADOLPHE LE BŒUF, *of Paris.—Patent dated 2nd August*, 1867.

THIS invention relates to a peculiar construction and arrangement of hydraulic lift, and consists, firstly, in the use of a slotted column within which a flexible metallic packing band or blade is fitted, in order to close the said slot; such packing being opened and closed again, as required, by an arm connected with a double piston, which is caused to ascend inside the column by water pressure acting from below. The slot or opening in this vertical column is closed as fast as the piston rises by the before-mentioned internal flexible metallic packing blade, which is withdrawn from the slot (so as to open the same) at the part contained between the two pistons, in order to allow of the passage of the connecting arm to which the platform or platforms of the lift is or are to be attached. Another part of the invention consists in working hydraulic lifts in which a pressure of water is required, by the aid of what is known as the Giffard injector, in lieu of by a force pump or other like means of obtaining fluid pressure. Fig. 1 of the engravings is a vertical section of the lower portion of the improved hydraulic lift. Fig. 2 is a sectional plan; and fig. 3 is an enlarged horizontal section, showing the arrangement of the metallic blade or band packing, hereafter more fully described and referred to. A represents a tubular or hollow column of any desired height, according to the amount or height of lift required, such column having a slot or opening on one side extending throughout its entire length. In the interior of the said column there are fitted two pistons, B B, packed with cup leathers, or otherwise, and connected together by a short coupling or rod, C. Midway between the two pistons there is secured to the said rod or coupling, C, a horizontal forked arm, D, which passes out or projects through and traverses along the slot in the column as the pistons ascend and descend therein. Each side of the slot is by preference faced with a strip of steel or other metal, *a a* (fig. 3), so shaped on the inner edge as to form recesses for the reception of two longitudinal strips of vulcanized india rubber, *b b;* these strips of rubber constitute the seating for the thin flexible blade or band of steel, copper, or other suitable metal, *c*, which is placed inside the column, A, and extends from top to bottom thereof, and by being pressed close against the inner side of the slot by the water pressure in the column below the pistons, serves effectually to close such slot and prevent any escape of water through it. In order to allow of the free passage or traverse of the D ojrke,darm, along the slot, the above-mentioned flexible metallic packing blade, *c*, passes between or inside the two jaws of the said forked arm, secured to the piston rod or coupling, C, and bears against the closed end of the fork, as shown clearly in figs. 2 and 3; so that at the part where the arm, D, passes through the slot, the packing blade, *c*, will be drawn towards the interior of the column, A (see fig. 1), and will leave the slot exposed or open for the passage of the arm, D. As this opening or exposure of the slot only occurs at the part embraced or inclosed between the two pistons, B B, which work fluid-tight in the column, no leakage can take place; the lower piston being made to close or press into its place against the flexible metallic packing blade, *c*, as it progresses upwards. The platform or platforms, E E, for the reception of the loads to be elevated, are connected to the protruding end of the arm, D, by cross arms, F F, rivetted to the arm, D, which cross arms are connected by suspension rods, G G, or otherwise, to the platforms, E, two of which are by preference employed, disposed so as to balance each other on each side of the column, A. In order to avoid any lateral strain on the pistons, B, the cross arms, F, are so bent back as to bring the points of connection with the suspension rods, G, of the platforms in the same plane as the axial centre line of the vertical column, as shown clearly in fig. 2. This lift may be actuated by water pressure obtained in any well known manner, either by pumps or by head pressure, or, where steam is available, by the aid of a Giffard's injector.

Fig. 1.

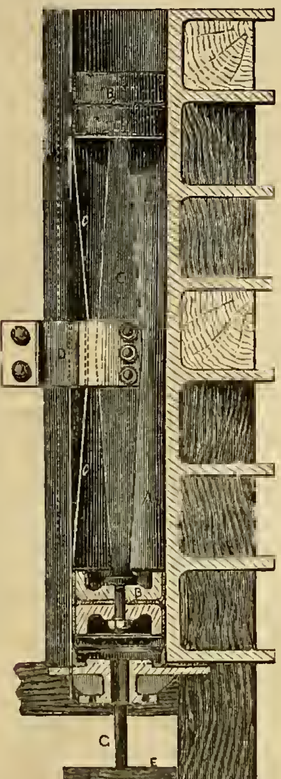


Fig. 2.

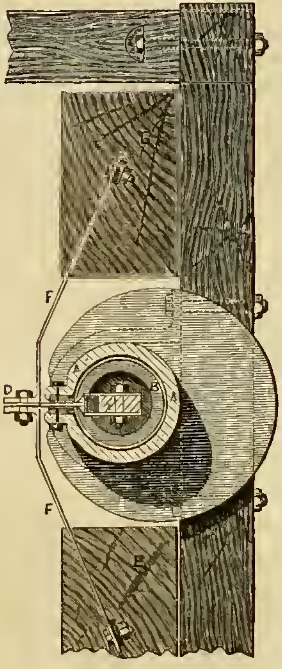
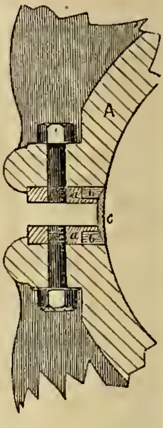


Fig. 3.



REVIEWS OF NEW BOOKS.

NIMMO'S HANDY BOOKS OF USEFUL KNOWLEDGE.—METALS AND THEIR USES.—FREE-HAND DRAWING. Each 1 vol.

THE first-named of this small and cheap series of volumes for "young people," *i.e.*, for educational or informational use, is a perfectly intolerable production. Surely the author who ventured to launch such a piece of stupid, ignorant inaccuracy upon the world must have had more acquaintance with "brass" than with all other metals. Who Mr. Joynson its author may be, we know not, nor what nor where he has studied; but the fountainheads of knowledge of his professed subject seem not known to him, whilst he muddles perpetually amongst obscure and worthless trash extracted from this and that journal or paper. Mr. Zerah Colburn, that paragon of pretension to accuracy upon all subjects, seems to be his great metallurgic mentor and guide; is this a deprecatory offering to that elegant and impartial critic? We may judge of this edifice at least, by a few samples of its material. Here are a few brick-bats picked at random from the rubbish heap. Page 14:—"The material of which the slag produced in the (iron) furnace is formed, and *which is called 'gangue*,' and which is composed of quartz and clay, exercises also a very deleterious influence upon the iron produced." "*Gangue*" we previously supposed, with the rest of the world, meant the foreign mineral masses that surround a vein or bed of ore *in situ!* the deleterious influence of that on the melted metal of the ore was reserved for Mr. Joynson to see. We say nothing as to the alleged deleteriousness of quartz and clay in pig-iron making!

"The most eminent metallurgists, headed by Karston," &c., page 30. Pray, who is or was the renowned person who bore *that* name? Is he the same as one Karstein named at pages 46–47? and are both meant for M. Karsten? In these last pages we have all the old rubbish about the improvement of cast iron by remelting it, just precisely thirteen times; perhaps information on such a subject, however, was too much to expect.

In the next page or two: "In America 'chilling' is largely resorted to for railway wheels, and *in the casting of cannon*." It chills our blood to learn that; but incredulity comes to our rescue. "In chilling iron, Mr. Colburn says that it is for the founder to ascertain the iron that will chill and those that will not." Most excellent advice, and worthy of the prophet, though in some degree anticipated by Mrs. Glass' "first catch your hare;" but would Mr. Colburn inform us of any cast iron, of any make under the sun, that will *not* chill if it be properly treated.

What are "*reverbating*" furnaces, mentioned at page 54? can they be our old acquaintances reverberatories?

Mr. Colburn is again quoted at page 53, for his explanation of the phenomena of welding. The explanation is as clear—as mud. A writer, quoted from another of the author's great metallurgical sources, *The Mechanics' Magazine*, does start some difficulties to the Colburnian explanation. They stagger us; but no doubt fail to affect the Joynsonian mind, for the whole affair is dropped, between these two stools.

Chap. III., page 76, begins thus:—"Steel occupies a position between wrought and cast iron, containing what may be called an *intermediate quality* of carbon." Poor steel, a little better than cast, and rather worse than wrought iron, thus degraded from having got into company with this vulgar, *intermediate quality* of carbon. We should be very curious to know exactly what this "middle-class" carbon is. The diamond is the genuine article—the "real quality"—the "rank and fashion" of carbon, as we all know, and London smuts may be supposed the *canaille* of the same; but what can this middle-quality carbon be? nobody seems to know, not even Mr. Joynson himself; certainly we do not.

Next page, 77:—"The retort thus filled is gradually heated by a slow fire till the temperature reaches the point of 100° of Wedgwood's pyrometer; to alter which temperature it takes about twenty-four hours." What lucidity! Can any one tell *what* temperature is 100°, or any other, whatever it may be, of Wedgwood's pyrometer? What is the "*it*" which takes twenty-four hours to alter this, by even a single degree?

Page 90:—"On the Continent the German process of refining is used, *and* (*sic*) a steel being produced from crude iron by the decarburizing effect of a blast in a refining furnace. Charcoal is used to melt the pig iron, and a strong blast is projected over the surface of the molten *lead*, the mass being stirred up so as to bring the whole under the prismatic process." To gather any sense out of this surpasses our powers.

We then come to "Mr. Bagenly's" process, at work near Paris. By this we are told:—"The ore after five days is changed into what is called by the manufacturer 'spurge.'" It was with some difficulty we conjectured that this "spurge," repeated again in the same page, is some inconceivable blunder for *sponge*—the *sponge* of the manufacturers.

Page 92:—Is Uchateus the inventor of the so-called Uhcatius steel process, which is described as "atmospheric air sent through the metal for the space of fifteen minutes, on one side, the other side being heated with a mixture of hydrogen and carbonic oxide gases, *fuzed* from sulphur."

Page 100:—"Galena is associated with iron and copper pyrites," and a something called "*blench*," meant probably for blende.

At page 113 we have a valuable recipe for practical metallurgic cookery:—"Case hardening of iron with arsenic. Rasped leather or horn is mixed with a solution of arsenious acid, dissolved in hydrochloric acid to the consistency of common porridge." Perspicuous language! The metal is painted over with this to the thickness of, just $\frac{1}{16}$ of an inch, and it is heated to redness. The surface is converted into arsenide of iron of great hardness, and rust-proof. Mr. Ekman, a Swede, is quoted for this:—"But some partial experiments by Dr. Percy do not quite confirm the value of the process." We should expect not; though it is not clear whether Dr. Percy's experiments are charged here with partiality, or whether he himself is charged with partiality, for or against the *solution* of arsenious acid *dissolved* in hydrochloric, or what.

Page 121. *The Mechanics' Magazine* is made responsible for the "useful note" that, "Generally speaking wrought iron suffers nearly three times as much as common cast iron from corrosion;" "spiegeleisen, on the other hand, scarcely at all." This is "the beautiful generality which casts away all conditions;" unfortunately here it is not true for any one conceivable set of conditions.

We shall go no further. To the length we have already gone in noticing this stupid little fardel of inaccuracy and half knowledge, we are open to the accusation of breaking a fly on the wheel; but we are not without justification. This is but an exaggerated sample of a vast proportion of the wretched trash which is doled forth by publishers of popular so-called scientific and technical information, and the diffusion of which is positively mischievous; for it goes into the hands of those who, as a class, are unable to detect the falsity and the insufficiency of that which they accept—as most ignorant people do whatever they find in type—as so much gospel. The production of popular useful knowledge series is a regular trade, at a shilling a volume. The publisher calculates that he cannot make "the article" sell, unless paper, printing, and authorship are all got within a certain very narrow margin; the two first cannot be squeezed below a fixed figure, but the price of authorship may, by the simple process of employing some incompetent and perhaps needy man.

Such books as this could not be sold at all in France or Germany. The very want of discriminative power that enables them to be speculated in and to be sold in Great Britain, is one palpable indication of the low standard of education of our middle-class *et infra*.

Another volume of this "Nimmo Handy Book" series, "On Free-hand Drawing," is better done by far than the preceding work, and in the main is rather a useful boy's book. But even this is not free from some objectionable matter. For example (page 75):—"We believe that a knowledge of perspective never did much towards making a great free-hand draughtsman;" and then one of Mr. Ruskin's ill-reasoned out illustrations is given in support:—"No amount of perspective knowledge will teach one how to draw the curve of a river's bend," &c., like so much that that gentleman has uttered—specious, but wrong. Free-hand drawing in reality is the education of the eye and hand in concert, in the production of design, and can no more be acquired by the intellectual acquisition of principles of any sort—geometrical, optical, or both, perspective—than swimming by a course of hydrostatics. But the swimmer may improve his swimming, and even better teach another, if he possesses clear ideas of the exact principles upon which the fluid supports him, and by which he moves himself in it; and so the free-hand drawer of the most irregular natural objects will be likely to be a more exact and certain and rapid draughtsman, by acquaintanceship with the scientific principles of all perspective in regular or irregular objects, which in the end he comes to apply, as it were, intuitively to test the work of his own eye and hand.—Ed.

FOREIGN LITERATURE.

Franz Rziha continues his magnificent work on tunnelling, *Lehrbuch der Gesammten Tunnelbaukunst*, &c., which has now arrived at the fourth part of the first volume. In the preceding parts he dealt with shaft boring and level driving for mining purposes, and the apparatus and methods of proceeding, machine boring, timbering, &c. In the present part he deals elaborately with all conditions possibly occurring in nature of shafts and tunnels for railway and like uses, in reference to the conduct of the work from first to last, and the various methods of timbering, centering, &c., as adopted in various countries, and under many different circumstances.

The treatment of the subject proves the author intimately acquainted with practice everywhere, and is illustrated by wood-cuts and descriptions in brief of several of the most interesting and important tunnels in Europe.

In both shaft sinking through water-swimming strata, and tunnelling under difficulties, the continental engineers have, we fear it must be conceded, left us behind; perhaps in some degree because of late years we have not had the same demand for tunnelling in Great Britain that the long continental lines over mountainous regions have forced upon foreign engineers. Whether this be so or not, certain it is that we possess no work on tunnelling in English at all to compare with this noble work of Rziha's. He is fully alive to certain advantages of our English methods, which he as fully describes. And one of the most valuable portions of his work to the practical tunneller will be found in his description of the failures, crushing in, &c., of continental tunnels, as, for example, of the Czernitz Tunnel.

How little our English engineers, in treating of tunnelling, would think of such exactness and patience as the German thinks of as nothing strange; as, for example here, bringing into a tabular form, derived from actual results in various great works, the weight and cost of "nails and dogs" (*klammern*) to the cube foot of wood consumed in timbering, and to the cube foot of finished tunnel space. Yet it is just upon such patient minutiæ that economy often rests, and at any rate the choice for the future, through the view back upon the past.

Herr Kerpely also has brought his useful and judiciously filled year book, descriptive of improvements in the iron and steel manufactures, *Bericht über die Fortschritte der Eisenhütten Technic*, &c., to its second year, and down to the end of 1865. In an appendix he has given a great deal of important information on the metallurgies of copper, lead, zinc, silver, and gold, also in this volume.

We cannot attempt to analyze the mass of notices of matter, more or less new, with which every page of this work is filled. There are few things more interesting in it than the results of puddling by peat gas furnaces at Mandelholz, in the Oberharz. The peat is oven dried, and the gas made in peculiar furnaces at a distance from the puddling furnaces. It appears that as compared with puddling with hard (*stein kohl*) coal dust, the 100 lbs. of puddled iron requires a volume of about 3 5, and a weight of 242 lbs. of dried peat, as compared with 2·5 and 100 to 113 lbs. of coal in mere dust.

If ever Irish peat is to be got into real use for any manufacturing purpose, it will be by employing it as gaseous fuel thus, and not by any nostrums of compression. There really seems no certain reason bricks and pottery, lead and copper smelting, glass making, and why possibly steel making, direct from the red hæmatites of *Leitrim*, &c., should not be made to succeed in Ireland with peat for gas fuel, so far as the metallurgic conditions alone are concerned. Another very interesting description given and illustrated in this volume is Thals' modification of the Bessemer process, in which the stream of cast iron, divided into drops, is spread by the centrifugal force of a rapidly revolving plate, on which it falls in the conversion chamber, and from which it passes directly as steel.

A work that may be examined with advantage in connection with this last is that of FERDINAND STEINMANN, C.E., of Dresden, *Compendium der Gasfeuerung in ihrer Anwendung auf die Hüttenindustrie*, with several plates, showing the vast progress that has been made in Germany in this and the regenerative systems of working furnaces and heat appliances throughout a wide circle of manufactures. The work is in one small volume, and published by Engelhardt, at Freiberg, this present year (1868).

SHORT NOTICES.

DER CULTUR INGENIEUR.

THIS is intended to be a quarterly journal of all such polytechnical knowledge as may be connected with, or of value to, the agricultural engineer. It is conducted by Dr. Fred. William Dünkelberg, a technical professor at the Agricultural Institute of Wiesbaden, and the first part has appeared, published by Wiewig & Son. Brunswick. 1868.

The style of papers shows a high aim in this first part, as does the prospectus and address to the public with which the part commences—too high, we are almost disposed to think, even for the educated standard of the German agricultural engineer. The first paper is one on the canalization (*i.e.*, sewering) and water supply of towns, with a motto taken from the well-known saying of our Lord Palmerston, "Dirt is only a thing out of its place," which looks odd in its German dress. The most valuable article is one on Comstock's rotary digging machine, which will much interest our Howards and Fowlers.

There is also an elaborate and critical essay on Humphrey's and Abbot's report on the Mississippi river, and a large amount of notices of new German works on agricultural science, &c. If the work holds to this style it will prove a valuable addition to more than agricultural literature, though from its language, unfortunately, likely to remain very much a sealed book to our own agricultural community.

WE have received several parts of the cheap series of separate treatises on technical subjects, published by Carl Macken, of Stuttgart, each with an atlas of plates in small folio, the volume being in small 8vo.

The treatises before us are—"Heating and Ventilation in relation to Manufacturing Purposes," by Schintz; "Tables and Memoranda of the Weight, Strength, and various general and special Properties in different forms of Rolled and Forged Iron, &c.," by E. Mäuer; "The System of Laying out and Constructing Curves and Crossings, &c., upon Railways," by Rell and Kauffmann—a volume replete with a vast quantity of useful tables, data, and other information theoretic and practical; "The Rational Construction, Setting, and Working of the Steam Boiler," by D. Fallenstein, also a full and valuable volume. We must protest against the paper and typography. The use of the old German character, however much Germans may love it patriotically, ought to be abandoned in all works intended for circulation out of fatherland at least, and German printers should take the style of their symbol-printing from the types adopted by France and England, now the clearest and best in the world, and not adhere to their abominably ugly, uncertain, and unreadable old notations with upright Roman letters for everything.

LES ANNALES DU SAUVETAGE MARITIME, for 1865 and 1866, have been forwarded to us by the Société Centrale du Sauvetage des Naufrages, of Paris. This society is for France what out life-boat societies are in Great Britain, and something more. These reports are full of interest and import, and though almost unknown in England, embrace a mass of admirably arranged statistics of great value bearing on shipwreck and the means of saving from its results.

At the end of the year 1866 the lighthouses of the whole world were as follows; and their mean distances apart along the coasts as given in the right-hand column:—

	Number of Lighthouses.		Kilometres apart.
Europe,	1,785		35·23
Asia,	162		532·85
Africa,	93		431·73
America,	674		162·41
Oceania,	100		1,148·73
Total,	2,814	Mean,	147·01

It may be seen at a glance how much remains for governments and the lighthouse engineer to do here for suffering humanity; here is one path of engineering at least, which, so far from being "used up," is little more than in its infancy.

By the classification of the wrecks of five years, giving a total of 1351 upon French coasts, it appears that 444 were due to stress of weather, 93 to wrong courses through winds, tides, or currents, 149 to foundering, 88 to negligence or want of seamanship, or other unskilfulness, 288 to damages received at sea, to loss of cables, leakage, or the *age and worn-out* character of the ship, and 166 to being insufficiently provided with information. All the other causes are small in effect. While the preponderant number, just one-third of the whole, are due, therefore, to the "dangers of the seas," which those that go down to them in ships can never wholly escape, a very large proportion are due to perfectly preventible causes. Within the same five years, 1862 to 1866, the number of persons drowned by shipwreck on French coasts was 1035. The wreck chart for the coasts of France and Algeria for 1865 is well produced, and points clearly enough to the points of greatest peril. The mouth of the Seine, on the north coast, seems still to hold something of its ancient bad pre-eminence. Unless, however, we knew the total number of ships passing or arriving at each point of coast, and so could obtain the ratio of the safe to the destroyed, this or any other wreck chart is defective of its most important data.

THE first part of M. LACROIX's extremely well-supported and well-conducted journal, *Annales du Génie Civil*, that for January of this year, has reached us. It contains a good article by M. Stutz, C.E., on the brake with articulated or jointed wedges upon the Stilenant system, to which a large silver medal was awarded last year at Paris. Amongst the other articles is one on a new form of drawing apparatus for colliery uses. The cages are screwed up and down upon two fixed but rotating screws of rapid thread, extending from top to bottom of the pit. Of course the "cages" can never fall, but we should entertain the strongest doubt of their ever going either up or down in a really deep pit; and as to the rate of motion, it would probably never reach one-tenth of the speed common in collieries with existing machinery. A very valuable article follows, descriptive of one of the great French "*barrages*," or embankments of a torrent, "The Habra," in Algeria, by a masonry dam based on rock. Amongst the smaller articles is a very curious, and by no means unimportant one, descriptive of a case of the production of poisonous bread, by that having been baked in an oven heated with wood from old railway sleepers, which had been coated with certain poisonous metallic paints.

M. EUGÈNE LACROIX, the well-known publisher of Paris, also continues his useful and generally meritorious volumes of his *Bibliothèque des*

Professiones Industrielles et Agricoles. Amongst the last volumes that have reached us is, *Les Droits des Inventeurs*, by M. Dufrene, a practical little book of information and advice to inventors and patentees, &c. It is brief and terse, and yet takes a very wide scope, inasmuch as it describes, in a sketchy style, the, so to say, geographical distribution of industries and manufactures over the civilized world; and then the laws and rights of patentees, inventors, owners of designs, trade marks, &c., &c., in the various countries of Europe. It is, of course, but a popular or introductory work; those requiring extensive and reliable information on points in dispute as to invention or patents will seek larger works, such as the great volume of M. Scheuol, published by Baudry, Paris.

Professor von Clausius has published in a separate form a paper of his given to the Frankfort Natural Science Society in September last, on the two main laws of the mechanical theory of heat. (*Uber den Zweiten Haupsatz der Mechanischen Wärmtheorie. Wieweg und Sohn. Braunschweig*, 1867.) We shall not attempt to analyze the paper, which, though but a few pages, is best read entire by those interested, and who have sufficiently followed the advance of this branch of physics to do so.

The journal of the German Engineers' Union, *Zeitschrift des Vereines Deutscher Ingenieure*, conducted by Herrn Grashof, Werner, Lift, and Ludewig, all C.E.'s, and published at Berlin, in 4to, with excellently well-executed plates, has reached us for the last quarter of 1867. There is here a vast mass of collected information, though less of original communication than might be expected. Amongst the articles of the latter character, one upon the History of the Development of Industry and Manufactures in Germany from the earliest periods of history to the present time, we have looked into with great interest.

The Tangent Photometer of Dr. Ferdinand Bothe deserves the attention of our gas-making readers.

If the co-editors of this creditable journal desire that it should be known and read as extensively as it deserves in France and England, to say nothing of America, they should change their type from the old Gothic character to the Roman. It is quite true that there are few or none who can read German (as foreigners), who cannot read it in the old character, but it is one thing to read, another to read with rapidity and comfort to the eye; and probably no alphabet out of Asia so effectually tortures the vision as the Gothic, especially where, as here, very closely printed.

Guide Pratique de la Culture du Saule et du Roseau, by M. Koltz, is an excellent treatise on the cultivation, economy, and uses of willows and reeds, two branches of agriculture greatly neglected in the United Kingdom. The extent to which reeds, not only the *Arundo phragmites*, but the larger *Arundo donax*, are employed for constructional purposes, ceilings of cottages, roof thatching, fences, &c., &c., on the Continent, and especially in the South of Europe, is almost unknown to us. Yet there are thousands of useless swampy acres in almost every part of the British Islands, producing little or nothing, that might be made thus almost without any trouble or outlay, after the first, to give a fair return. In Ireland especially ought willow or osier culture and basket-making become a great trade. That country has natural advantages for producing the material, and its manufacture needs but little skill or capital.

Guide Pratique pour le Choix de la Vache Laitière, by M. Ernest Dubos, is a volume which, with its capital history of milk, and its falsifications and methods of dilution, &c., with which it commences, and its beautiful wood engravings of choice cows of all the chief characteristic European breeds, ought to interest every one, for from the sucking infant to the second childhood that preludes mere oblivion, we are all personally interested in milk and milk givers. To the practical and scientific farmer the volume will, however, be not only of interest but of value. We do not recollect any similar brief and good treatise on milk and the cow in England.—Ed.

The Transference of the Telegraphs to the State. By John Stephen, Electrician. A pamphlet (Longmans, London, 1868), cleverly written, touching upon a vast variety of topics more or less germain to the primary question; viz., the advantages to the community at large of this proposed transfer. The author gives several good reasons in support of his views, that the ultimate public advantage must prove great, although the state may for years reap no direct money profit from the telegraphs.

Sunday telegraphs, and in Scotland too, are touched upon, and a really important subject—the extensive employment of women as telegraph clerks, in the event of this transfer being effected. The openings created thus for what is so much needed—viz., suitable honest employment for fairly educated women—would be very numerous. No wise and humane legislator should at present, in England and Scotland at least, neglect these.—Ed.

On the Reports of the Artizans Selected to Visit the Paris Universal Exhibition of 1867. By William Hawes, Esq., F.G.S. This is a separate print of a paper read by Mr. Hawes, chairman of the council, before the Society of Arts, Adelphi, and in its appendix the so-called reports of those artizans are given in extract. Nothing could have been better or wiser than the selection of intelligent workmen in various trades, and sending them at the expense of the Society of Arts to learn what they could at the late Exhibition; and probably no great objection would properly arise to receiving from these men some memoranda as to their impressions, and what they had picked up new or useful. We entertain the greatest doubt, however, as to the wisdom, in any sense, of trumpeting those very generally very weak and jejune productions of half-educated men, seeing, in a country where most of them were ignorant of a word of the language spoken round them, things necessarily understood but imperfectly, and only in some of their relations; and attempting to make the world believe that the Society has elicited and discovered superhuman talent in these workmen, and so persuading the men themselves that they are fit to teach others, rather than desiring further teachers for themselves.

PATENT OFFICE ABRIDGEMENTS.

Abridgements of Specifications relating to the Preparation and Combustion of Fuel, A.D. 1620–1865. 1 vol. 12mo. Pp. 1407.

Hydraulics, 1617–1867. 1 vol. 12mo. Pp. 1440.

Raising, Lowering, and Weighing, 1617–1865. 12mo. Pp. 1204.

Railways, 1770–1863. 12mo. Pp. 538.—London, Patent Office, 1867–68.

We have received these abridgements, prepared under the supervision of Mr. Bennett Woodcroft, and find them, as their predecessors have been, of extreme use to inventors and to those advising inventors. No inventor should file an application for a patent without in the first place referring to the Patent Office Abridgement of the class to which his invention belongs. If this course were pursued there would not be so many applications for patents for the same invention as hitherto. It is to be hoped that no time will be lost in completing abridgements of all patents. If they are as well done as those before us, the public will have no reason to complain of the expense incurred. It has been stated that, in place of the abridgements prepared by gentlemen specially selected as possessing the requisite talent for that purpose (no common faculty, by the way), the Patent Office intends to publish the abridgements now lodged by patentees and their agents with their provisional specifications. If this statement be correct the abridgements will not be of the slightest value, as they can never be depended upon as being true abstracts of the inventions.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

SMOKE CONSUMPTION.

(To the Editor of the Practical Mechanic's Journal.)

Dear Sir,—Our rulers have by their legislation on the subject declared, that it is desirable for the health and comfort of the inhabitants of our large manufacturing towns that the smoke nuisance ought to be suppressed. Many projects and patents have been put forth for accomplishing the object by improving the construction of furnaces and furnace-doors, in order the more thoroughly to consume the fuel. The application of such apparatus, except by a few careful individuals who give great attention to them, is practically neglected, and the Smoke Act is in many places little better than a dead letter.

Seeing that smoke consumption is a partial failure, I have to propose that smoke washing should be tried. The idea suggested itself to me while reading the description of Mr. John Reid's excellent gas-washing apparatus, which appeared in the *Practical Mechanic's Journal* for January. Those who have looked at the drawings and read the description will readily perceive the applicability of its essential principle to the purpose of smoke purifying, and that if the smoke made by every furnace had to pass through such an apparatus we would have a much clearer atmosphere to breathe in. Providing there is a sufficient distance between the furnace and chimney, a much simpler arrangement may be adopted for creating the shower or spray upon the smoke current as it passes along the horizontal portion of the flue, such as covering the top of the flue with perforated plates, and directing water to flow by gravitation upon them, which after falling through the current of smoke is led off by a trap arrangement at the bottom of the flue, carrying with it the much anathematized blacks, and other chemicals which contaminate the air.

Perhaps some chemist may show that the watery shower would arrest and retain in solution some chemical substance that could be turned to profitable account; if so, then we may be sure the smoke would soon be all washed out of existence.

Mr. Reid's invention not being patented, is therefore open to all proprietors of smoky chimneys to experiment with and apply, if found successful.

Probably, seeing that our legislators considered it necessary to enforce the consumption of smoke, and the matter being of national importance, the Board of Trade might be induced to bear the expense of a few experiments with the view of testing this method, which if found successful might form the basis of an entirely new Act for abolishing the smoke nuisance in our manufacturing towns. The insertion of the above remarks in your columns may bring the subject under discussion, and elicit the opinion of scientific and practical men better acquainted with the whole question than,

Yours respectfully,

Dundee, *March* 2, 1868. J. H. MILNE.

[Smoke washing is not a novelty. It has been tried upon a large scale at Swansea. Great practical difficulties attend it, even in relation to manufactory chimney stalks; and as regards domestic chimneys it is out of the question. One of the most serious difficulties comes from the fact that draught is greatly interfered with, because after or forth of the point of application of the steam or water spray, the temperature of the flue can never be higher than 212° Fahr.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF ENGINEERS IN SCOTLAND.

ON CERTAIN POINTS IN THE MANUFACTURE OF MALLEABLE IRON, WITH SPECIAL REFERENCE TO THE RICHARDSON PROCESS.

By St. John Vincent Day, C.E., F.R.S.S.A., &c.

(Continued from page 372, *Vol.* 3, *Third Series.)*

The only analysis of pig iron from North Staffordshire that I possess contains the very high proportion of 1·07 of phosphorus, and 0·04 of sulphur.

It is a very remarkable fact that I have not been able to obtain many reliable analyses of black-band pig iron, or indeed of the other Scottish irons, that are guaranteed by authority; this is not only a peculiarly striking fact, it is, moreover, one to be greatly deplored. It is true that I am in possession of several analyses in which phosphorus does not present itself at all; this certainly is notorious, as it is well known that the black-band pig irons do contain a very large percentage of phosphorus, and I can therefore only suppose that this element, always most difficult of detection, has not been carefully sought for. The paucity of analyses in this respect is no doubt principally due to the fact that so much of the Scotch pig iron is used and exported from the country as "foundry iron." Now it is perfectly evident that for foundry purposes the presence of phosphorus is of considerably less importance than would result if the pigs were as largely used for

Table II.—HÆMATITES. SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE IN WHITEHAVEN AND ULVERSTONE DISTRICTS FROM HÆMATITE ORES.

Particulars as to the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
Red Hæmatite from Whitehaven, Cumberland, and Cleator Moor.	0·01, 0·10, 0·05	0·053	0·05, 0·03, 0·06, 0·05	0·0475	Whitehaven Foundry Pig, Nos. 1, 2, 3, 4, hot blast.
Ulverstone Ore.	0·03	0·03	0·10	0·10	Pig iron made at the Newland Furnaces, Ulverstone.
Ores in the locality of Durham.	0·06, 0·04, 0·12, 0·04, 0·230, 0·06	0·09	0·07, 0·19, 0·19, 0·14, 0·12, 0·14	0·141	Iron smelted by the Weardale Iron and by the Forest of Dean Co., at Parkhead Ironworks.
Ulverstone Hæmatite (Anhydrous sesquioxide), 25 parts; Forest of Dean Hæmatite (Hydrated sesquioxide), 5 parts; Brown Hæmatite, believed to be from Frogball, 25 parts; Gubbin Ironstone, 10 parts (roasted); Bottom Whitestone, 5 parts (roasted).	0·05	0·05	0·29	0·29	Pig iron made by Messrs. Firmstone & Co., Lays Ironworks.
	Mean of Means,	0·056	Mean of Means,	0·1446	

Table III.—CHIEFLY ARGILLACEOUS ORES FROM THE COAL MEASURES. SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE IN SOUTH WALES.

Particulars of the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
Wholly of Welsh mine, without cinder or red ore.	0·11, 0·28, 0·46, 0·09	0·235	0·63, 0·63, 0·64, 0·63	0·032	Pig iron made at Dowlais, of which the first three samples were of No. 3 best mine pig, cold blast; mottled mine pig, cold blast, and white mine pig, cold blast, respectively; while the fourth was best mine pig, melted in a furnace with three twyers, of which two were hot and one cold blast.
Black pins, Pwll Llacca Bottom vein, Ball mine and Gray vein.	0·06, 0·07, 0·08, 0·08	0·074	0·38, 0·29, 0·27, 0·38	0·32	Made at Blanaevon with cold blast.
From the coal measures of the locality, the precise names of ore unknown.	0·06, 0·07, 0·04	0·059	0·32, 0·28, 0·33	0·31	Made at Blanaevon, and specified as cold blast gray pig iron, analyzed at the Arsenal, Woolwich.
Red or Welsh mine and cinder.	0·77, 0 73	0·75	0·82, 0·76	0·79	The first of these samples cast in chills, the second in sand, to ascertain the difference chemically by the two modes of being cooled. It is surprising that whilst so small a proportionate difference shows itself in the carbon, the proportionate difference in the phosphorus is very great.
From the coal measures in the locality of Pontypool.	0·12, 0·08, 0·09	0·096	0·32, 0·46, 0·50	0·426	Cold blast gray pig made at Pontypool.
Caus-y-Glo or Cheese mine, Pimmelyn mine, or yellow pin with red hæmatite from Ulverstone.	0·05, 0·06, 0·05, 0·05, 0·09, 0·06	0·06	0·41, 0·29, 0·38, 0·42, 0·38, 0·27	0·36 nearly.	Made at Ystalyfera, near Swansea, hot blast.
	Mean of Means,	0·098	Mean of Means,	0·473	

Table IV.—ARGILLACEOUS ORES FROM THE COAL MEASURES. SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE IN SOUTH STAFFORDSHIRE.

Particulars as to the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
Binds, whitestone, gubbin, and grains, proportions unknown.	0·04, 0·04, 0·03, 0·06, 0·05	0·044	0·34, 0·31, 0·43, 0·29, 0·44	0·362	
Ibid.	0·08, 0·07, 0·04, 0·08	0·0675	0·42, 0·42, 0·34, 0·45	0·40	Cold blast gray pig iron.
Bottomstone and binds; two-thirds gubbin, and rubble one-third.	0·06, 0·03, 0·10	0·63	0·58, 0·55, 0·48	0·53	Pig, gray—forge, and forge pig, respectively, cold blast iron made at the Parkhead Furnaces, Dudley.
Ibid.	0·08, 0·08, 0·05, 0·05, 0·07, 0·05	0·063	0·55, 0·51, 0·48, 0·49, 0·58, 0·60	0·53	Cold blast gray pig made at the Parkhead Furnaces, Dudley.
Gubbin one-half, whitestone the other half.	0·04, 0·05	0·045	0·72, 0·63	0·67	Hot blast and cold blast, respectively, from Earl Dudley's Level Ironworks, Brierley Hill.
Whitestone, gubbin, grains, pins, balls, and poor robins, with a little red hæmatite from Ulverstone.	0·03, 0·04, 0·07, 0·11	0·0625	0·38, 0·63, 0·55, 0·41	0·49	Pig iron made by Messrs. Badger & Co., Old Hill Furnaces, Dudley; whether by hot or cold blast is unknown.
Uncertain as to name.	0·08, 0·09, 0·09, 0·07, 0·07	0·08	0·36, 0·30, 0·41, 0·55, 0·23	0·39	Gray pig, both hot and cold blast, from Lays Ironworks, Dudley.
	Mean of Means,	0·0614	Mean of Means,	0·48	

Table V.—ARGILLACEOUS ORES FROM COAL MEASURES. SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE IN YORKSHIRE.

Particulars as to the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
Black bed ironstone from the coal measures of this locality.	0·05, 0·04, 0·06, 0·03, 0·06, 0·07, 0·04	0·05	0·50, 0·57, 0·56, 0·49, 0·44, 0·67, 0·52	0·54	Various kinds, specified as pig and gray pig made at the Bowling Ironworks.
Ibid.	0·06, 0·07, 0·05, 0·05, 0·04	0·054	0·52, 0·53, 0·64, 0·55, 0·55	0·558	Cold blast pig iron made at Messrs. Harding & Co., Beeston Manor Ironworks, Leeds.
	Mean of Means,	0·052	Mean of Means,	0·549	

Table VI.—ARGILLACEOUS ORES FROM THE COAL MEASURES. SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE IN DERBYSHIRE.

Particulars as to the Ores from which the Pig Iron is made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
The first three samples in this case made of Brown Rake ironstone, and the fourth from Blue Rake ironstone (ore roasted).	0·02, 0·02 0·04, 0·11	0·0475	1·09, 1·21, 1·15, 0·75,	1·05	Pig Nos. 1, 2, 3, 4, made by Messrs. Needham, Butterly Ironworks, near Alfreton, Derbyshire—hot blast.
Black and Gray Rake two-thirds, and Honeycroft, or Striped Rake, one-third.	0·02, 0·06, 0·05, 0·03, 0·05	0·042	0·72, 0·34, 0·72, 0·95 0·70	0·68	Various, foundry pig and gray forge pig, made at the West Hallam Ironworks.
	Mean of Means,	0·0447	Mean of Means,	0·865	

Table VII.—SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE ENTIRELY OF NORTHAMPTONSHIRE ORES.

Particulars as to the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
The usual ores of this neighbourhood.	0·197, 0·414, 0·702, 0·440	0·438	0·936, 1·807, 1·368, 1·300	1·127	
Ibid.	0·10, 0·13, 0·07	0·10	1·19, 1·07, 1·31	1·16	Made by Messrs. Battlin & Co., with cold-blast.
	Mean of Means,	0·269	Mean of Means,	1·1435	

Table VIII.—SULPHUR AND PHOSPHORUS COMBINED IN PIG IRON MADE FROM CLEVELAND ORES.

Particulars as to the Ores from which the Pig Iron was made.	Sulphur per cent.	Means of Sulphur.	Phosphorus per cent.	Means of Phosphorus.	Remarks.
Uncertain.	0·03, 0·04	0·035	1·24, 1·30	1·27	Iron known as No. 2 foundry pig, made at South Bank Furnaces, Middlesbro'-on-Tees, hot blast.
Cleveland ore from Belmont mines, and a little red hæmatite.	0·04, 0·03	0·035	1·38, 1·36	1·37	Made by Messrs. Holdsworth, Bennington, & Byers, at Stockton Hot Blast.
	Mean of Means,	0·035	Mean of Means,	1·32	

making malleable iron as the English, Welsh, and Continental ores. It being certain that the presence of phosphorus has so much to do with the tensile strength of malleable iron, this, no doubt, has been the chief incentive to the undertaking so many careful analyses of those pig irons from which malleable iron is principally made, in order that to produce the highest quality of finished iron, ores containing the least amount of phosphorus might be selected.

I may call attention to one analysis of Scotch black-band ironstone, which we may safely take as a very fair mean representative of the productions of this country—it is from Gartsherrie, and my authority for it is a report made to the Prussian government by M. A. Erbeich. In the raw state it gives phosphoric acid (Po^5) 0·90, which corresponds to rather above 0·5 per cent of phosphorus in the pig iron, but we may with safety take it at 0·5 per cent., for the sake of avoiding error in excess. Some samples of Scotch pig iron give sulphur and phosphorus in other proportions; for instance, some No. 3 gray coke iron from the Calder Ironworks contained sulphur 0·35 and phosphorus 0·39, and another specimen from Clyde contained sulphur 0·40 and phosphorus 1·30; the former of these is probably a fair mean representative of the quantities of sulphur and phosphorus combined in irons from the Scotch coal measures, whilst the latter is no doubt an extreme; taking, however, the mean of these three, we get—

Sulphur,	0·375
Phosphorus,	0·63

From the appended tables we have the values of British pig irons in regard to phosphorus represented in the following scale of ascending values of the quantity of that element by their mean of means:—

	Phosphorus per cent.
Hæmatites (various),	0·144
South Wales,	0·473
Staffordshire (South),	0·48
Yorkshire,	0·54
Scotland,	0·73
Derbyshire,	0·865
Staffordshire (North),	1·07
Northamptonshire,	1·143
Cleveland,	1·32

On the other hand, taking the mean of means of sulphur we get the following order of ascending values in respect of the quantity of this element contained in the ores of different localities of Great Britain:—

	Sulphur per cent.
Cleveland,	0·035
North Staffordshire,	0·04
Derbyshire,	0·0447
Yorkshire,	0 052
Whitehaven (Ulverstone),	0·056
South Staffordshire,	0·0614
South Wales,	0·098
Northamptonshire,	0·267
Scotland,	0·283

Now, since the effect of combined sulphur is to prolong the time of melting, and phosphorus, on the other hand, diminishes that period, comparisons like those we have made are extremely useful in indicating the other chemical conditions in addition to those produced by the presence of carbon and silicon, that affect the duration of the period of melting of pig irons made in different localities. I am now, of course, speaking independently of the construction of the furnace, for this modifies the time of melting to a considerable extent, a high bridge and great depth of hearth tending to drive off and prevent the tips of the reverberated flame from attacking the charge so easily as in a furnace with a low bridge and shallow hearth. In the case of the Cleveland ore, we see at a glance that in the phosphorus series it is the very last, whilst singularly enough in the sulphur series it takes the first place; this theory shows it should be a very fast-melting pig iron. In the case of North Staffordshire it is second in the sulphur series and seventh in the phosphorus series; the presence of sulphur being low and that of phosphorus very high, it should be a very fast-melting iron. In the case of Derbyshire the phosphorus is much lower than in the preceding, and the sulphur but very slightly increased; it therefore should take a little longer in melting than the North Staffordshire pigs. In the case of Yorkshire the sulphur is increased and the phosphorus diminished; the time of melting should be longer still.

By making comparisons like the foregoing we obtain the period of melting of British pig irons in terms of the combined sulphur and phosphorus in the following order:—

CLEVELAND,
NORTH STAFFORDSHIRE,
DERBYSHIRE,
YORKSHIRE,
NORTHAMPTONSHIRE,
WHITEHAVEN, ULVERSTONE (HÆMATITE),
SOUTH STAFFORDSHIRE,
SOUTH WALES,
SCOTLAND.

Here we see the order is nearly the same as in the sulphur series, the exception being in the case of Northamptonshire pig, where the percentage of phosphorus is so very high that it predominates over the sulphur, and therefore materially shortens the period of melting. If these conclusions which I have deduced are compared with practical results they will, I believe, be found to very fairly coincide. In the case of Scottish irons these should take longer to melt than any others present in this country, and from the number of trials at different works that have been made on this point, such deduction will, I believe, strictly correspond with the practical results.

We have now to consider the extent to which phosphorus and sulphur are removed in the ordinary process of puddling. On this point I have not had time to prepare tables, as in the case of pig iron, but it is my intention to do so on the earliest opportunity, as their value is evident enough to any one whose pursuits are directed towards improving the metallurgy of iron and steel. On the present occasion, then, I shall, to shorten the time I am occupying, merely bring forward analyses from the very best makes of malleable iron I have met with, some of these being taken from Dr. Percy's excellent work on "Iron and Steel." An armour plate made at Lowmoor was found to contain 0·104 per cent. of sulphur, and 0·106 per cent. of phosphorus; now, as we have before seen, the mean values for Yorkshire pig iron are—

Sulphur,	0·052
Phosphorus,	0·549

in which case, either in the puddling or re-heating furnace, but most probably in the former, the sulphur is doubled, but the phosphorus diminished by the very great amount of ·433 per cent. This, however, being an armour plate, is a special case; and it is highly probable that a portion of better pig iron was mixed with the Yorkshire pigs ordinarily used at Lowmoor. The sulphur is considerably increased: it may possibly have been added from the fuel. In several other specimens of armour plates we find sulphur existing in the following percentages:—

Sulphur, 0·058, 0·121, 0·190, 0·118, ·058, 0·104;

and phosphorus in the following:—

Phosphorus, 0·030, 0·173, 0·020, 0·228, 0·089, 0·106.

In regard to the sulphur, it is higher in the examined plates than in all the different qualities of British pig iron except two, namely, Northamptonshire and Scotch; and since it is not in the least likely that either of these pigs were used in producing the plates, we may infer that sulphur has been added to the iron during its conversion and working into the malleable state, whilst the phosphorus is eliminated in every case to a very large extent, bringing its percentage considerably lower than in any known analysis of British pig iron. Comparing again malleable iron of South Staffordshire with the pig, we have for the former:—

Sulphur,	0·165
Phosphorus,	0·140

Here also the sulphur is increased and the phosphorus diminished to a very considerable extent, and the same result obtains generally with any other comparisons that we may make. We are therefore led to infer that during the conversion of pig into malleable iron, sulphur is added to the iron from the fuel, whilst the phosphorus is eliminated in a very large ratio. Of course, in considering the increase that takes place, we must bear in mind that the percentage in malleable iron is greater in proportion to the absolute amount of iron itself present than obtains in the pig iron, for the reason that in the latter case the carbon and silicon are present, whereas in the former they are nearly eliminated.

Comparing the foregoing results with analyses of iron made by the Richardson process, the superior eliminating power of that process is forcibly striking. In the analyzed samples of the iron made at the Glasgow Ironworks by that process, as I have before stated for the experiments, common Scotch pigs were used; and yet from that material we have obtained finished bar iron purer than anything that has ever heretofore been manufactured from British ores, and that, too, from pig irons which contain the highest percentage of sulphur, and rather above a medium of phosphorus; indeed, the removal of these two elements is so nearly complete, that practically they are not found. There can be no doubt remaining that the Richardson process has effected what has never before been done in Great Britain; by it we are enabled to produce a better and purer iron from the commonest pigs than we can yet depend on obtaining continuously by the common process of puddling from the best pigs. We can save a third of the time hitherto occupied in puddling, get a higher yield, save fuel, and therefore cheapen the production of malleable iron.

For the last two or three months there have been several furnaces making iron by this process at Parkhead. I have a large number of the returns as to the time of puddling a charge, besides a large number of results which I have noted myself from watching the conduct of the process on several occasions; these, however, I have not had sufficient time to tabulate, but I may state that the time from the moment of charging to taking out the balls varies from one hour fifteen minutes to one hour thirty minutes; whilst in another experiment that we made, having previously "fettled" the furnace very heavily all round, both the bridge, sides, and flue, the heat was out in one hour twenty minutes; this, without the fettling, would correspond to about one hour and ten minutes, a remarkably short time, when we remember that at this forge, where very gray pig iron is principally used, the amount of time usually occupied for puddling by the old method is one hour forty-five minutes, and very often two hours. The period of melting in the case of such pig iron is very high: I have on several occasions noted it and find it to vary between thirty-five and fifty minutes; this is doubtless due in a great measure to the high percentage of combined sulphur, and very probably to some extent depending upon the large proportion of silicon contained in it, as well as the hæmatite, a small portion of which enters into the mixture. Out of the hundreds of bars that have now been made in this manner at Parkhead from the "common mixtures," too, it is particularly important to remark that not a single bad bar has been met with. The iron works better under the shingling hammer as well as the rolls. In the puddled bars, after they have passed through the mill and are cooled, their appearance externally is frequently as smooth as good finished merchant bars, whilst the fracture shows the perfect regularity of the metal. With puddled bars of the same mixtures made in the ordinary manner, when cold and worked to the same extent, they are much more full of flaws and fissures gaping wide open at the surface, and the fractures always show much want of uniformity, while the microscope usually reveals the presence of a great deal of graphitic carbon. Puddled bars from the common mixtures will not usually bend through a greater angle than 40 degrees, without cracking right across; some of them break off quite *cold-short* before having reached that angle; whilst the best bars of such mixtures rarely if ever bend 45 degrees, and usually break in half before reaching that extent of flexure: but with bars made by the "Richardson process," out of precisely the same materials, I have seen them, I may with certainty say, on most occasions bend completely round to 90 degrees without breaking, frequently without showing a surface crack, and some specimens that have been tried were doubled up without effecting a complete fracture. Altogether, the advantages of working by this process are so great as to require no further comment from me.

Note.—Since writing the foregoing it has occurred to me that I should mention the now well-ascertained fact that in the puddling furnace some of the phosphorus passes from the charge into the cinder, but by no means the whole of it. This circumstance led Dr. Percy to propound his theory that still more of that element, existing in the charge as phosphide of iron, was liquated or sweated out after the metal was balled. If there be any truth in this supposition, it appears to be confirmed by the results of the mode of working to which I have now called your attention. The balling process is of longer duration, as I have already explained, therefore greater time is afforded for this supposed liquation of the phosphide. I merely throw this out as a hint; it is rather soon yet to attempt to form a conclusive theory. That phosphorus is not got rid of by oxidation in combination with iron is certain, or it would unquestionably be eliminated in the Bessemer converter—every means hitherto tried having utterly failed to remove it.

The President inquired whether any experiments had been made to test the tensile strength of the iron made by the Richardson process?

Mr. Day replied that the attention of Mr. Richardson and himself had hitherto been chiefly directed towards perfecting and obtaining a complete knowledge of the chemical features connected with the process, which he considered it was most important to be sure upon in the first instance, before proceeding into a train of experiments as to the mechanical qualities of the material; he had formed this opinion because it was daily becoming more apparent to those persons engaged in such investigations that when the chemical nature of a specimen of iron or steel was once known within the limits of as accurate an analysis as it was at present possible to make, that from this chemical knowledge the mechanical properties could be predicted within narrow limits of probable error. Another reason why chief attention had not hitherto been directed to ascertain exactly the tenacity, compressile resistance, the elongation or compression of the material under stress, or the various moduli of elasticity, rupture, &c., consisted in the fact that with the rough and ready although inaccurate style of test to produce the fracture of the "puddled bars" usually employed, the toughness and ductility of the metal had shown themselves so much higher than what resulted from bars made from the same (common) mixtures of iron by the ordinary process of puddling, that it was considered the accurate determination of these values might safely be left over until after certain other processes of the experimental inquiry were further advanced. Nevertheless, he believed one or two tests had been made at Messrs. Napier's, according to instructions given by Mr. Beardmore, the results of which had been to show that the *finished* iron, both in the direction of and across the fibre, was stronger and more ductile. However, upon these mere solitary tests he was of opinion that much weight should not be placed, particularly so, as the iron was amongst some of the first manufactured by the process, when the mode of working it was not so well understood as now. He did not remember the values exactly for these tests, but he had no doubt that Mr. Beardmore, who was present, would give them.

Mr. Beardmore said that the value shown by the tensional test was 27 tons per square inch in the direction of the fibre, and 23 7 across the fibre.

Mr. J. M. Rowan quite coincided with the sentiments expressed by Mr. Day, of the impossibility of removing either sulphur or phosphorus by the Bessemer process. If it had been done by the Richardson mode, it was more than Mr. Bessemer had done.

Mr. Day did not intend to convey the meaning that it was impossible to remove sulphur and phosphorus from molten iron when in the Bessemer converter. All he said was, that it had hitherto been found impossible to do so, although almost every so far available means for effecting their elimination had been resorted to. Chloride of calcium was, he believed, the last substance tried, and most persons expected, from the reports that were circulated concerning the valuable properties of this compound in the converter, that a cure for the evil had thus been found. The effect was tried, he believed, at Mr. Bessemer's own works at Sheffield, and the steel produced was analyzed in this country as well as in Germany, the results of which went to show, if he remembered correctly, that, according to the analysis made by Mr. Riley, the phosphorus and sulphur were eliminated in a larger ratio than formerly, whereas the German chemist's analysis showed the very reverse. This indicated that chemists had now a good deal to learn in arriving at a process of seeking for these two elements that might be considered practically accurate; for although both substances were in all cases most difficult of detection on account of their presence in such minute quantities, yet they so materially affected the value of the mechanical properties of iron that it was a most important item in the physical interpretation of this question that the percentage should be known with precision. He, however, was amongst those men who looked forward to the time when sulphur and phosphorus would both be eliminated from the charge in the Bessemer converter, although he did not think that at present it could be predicted how that was to be done.

Mr. Ferdinand Kohn said he had listened with much pleasure to Mr. Day's paper, and the remarks he had made as to the difficulties of removing sulphur and phosphorus from iron. He thought it right to correct an opinion hinted by Mr. Day, as to German chemists being superior in making analyses for the detection of phosphorus and sulphur. He thought Mr. Day was not quite well informed on that point. The case was the reverse; for Mr. Riley found more phosphorus in the steel than in the pig iron from which it was made. This was explained by considering that after removing certain impurities from the pig iron the quantity of phosphorus would apparently increase, on account of the diminished quantity of the total mass. He thought it due to Mr. Riley, who is a very clever and reliable analyst in this specialty, to correct the impression which might have been made by Mr. Day's statement. With regard to the statement that Mr. Bessemer had found it impossible to make iron by his process, and could produce nothing but steel, he wished to remark that a distinction between iron and steel could hardly be maintained on any precise scientific basis. The softest qualities of steel made by the Bessemer process, whether tested by chemical analysis or judged by their mechanical properties of flexibility and malleability, showed the same minute proportions of combined carbon and the same degree of malleability as the softest kinds of iron known in the market. Boiler plates and ship plates of Bessemer steel might now be seen at almost any first-class engineering establishment which would double up cold, and would permit to be bent and distorted to an extent equalled only by the very finest specimens of high-class wrought-iron plates. Samples of Bessemer steel were exhibited at Paris which had a smaller percentage of carbon than the average kinds of wrought iron are known to possess. The only possible distinction he could see between iron and steel was that the former contained particles of slag between the metallic crystals, while the latter was homogeneous and free from admixtures of slag. If this definition was adhered to, he believed that Mr. Bessemer would not be very proud to assert his capability to produce iron by his process; but, on the other hand, judging from the fine quality and homogeneous character of the bars made by the Richardson process, Mr. Richardson would ultimately be forced to admit that in some cases the product of his process was nothing but steel When the Bessemer process was first introduced the steel-masters maintained that the product was anything but *steel;* now it appears that iron-masters tried to say that Bessemer metal was anything but *iron.* Both statements, however, are entirely incorrect; the Bessemer process is capable of producing every variety, from the hardest steel to the softest homogeneous metal that any other mode of manufacture now in existence is capable to produce. It was true, however, that the Bessemer process was *confined to the employment of the purest qualities of pig iron,* and for this reason it appeared to him that the Richardson process, which was applicable to the inferior classes of pigs, had a wide range of utility, and was likely to become a process of vast importance.

Mr. Day was exceedingly glad of the opportunity Mr. Kohn had afforded him of putting the matter of Mr. Riley's analysis right. Mr. Kohn had referred to the different series of materials produced in the Bessemer converter. He remembered Mr. Kohn had read a paper before the British Association at their last meeting in Dundee, in which, as it appeared to him, the suggestion of indicating the continuity of the series of metals in a graphic manner by the aid of curves representing their mechanical properties was extremely valuable. This graphic representation was still further extended on the same occasion by Professor Rankine. With regard to Mr. Kohn's further remarks, purporting to show that there was no final line of demarcation between iron and steel, in theory he coincided, but for practical purposes there could be no question that it was most important to fix certain limits by which commercial transactions might be guided.

Mr. Downie asked whether in the working of the Richardson process the amount of work done by each puddler was greater than before—whether, instead of six heats, they could have eight heats per day?

Mr. Day said that was one of the objects aimed at, but the puddlers had hitherto frustrated this. He thought, however, by making the furnaces a little deeper, so that heavier charges could be employed, thereby they might get the equivalent of two extra heats per day.

Mr. Downie believed there was a difficulty in the way of turning out more, as scarcely any man could stand the labour of turning over so many charges.

Mr. Day replied that he had no doubt by the common process the present day's work was enough, but by the Richardson method the puddler's labours are considerably diminished.

Mr. R. Douglas wished to be informed of the brands, and, approximately, the analyses of the iron with which these experiments were made. Mr. Day had stated that the specimens exhibited were made from common Scotch brands; but as his interesting paper was so full of analyses, it would have been satisfactory to know somewhat definitely the quality of pigs used to produce these results.

Mr. Day replied that, on account of the great scarcity of reliable analyses of Scotch pig irons, he could not state exactly the chemical percentage of those brands used with the Richardson process, but, referring to the analyses given in the paper, it would be found by taking the mean of means what the percentage of the impurities amounted to.

Mr. Rowan stated that the average of Scotch gray pig irons contained phosphorus, 0·75; sulphur, 0·04.

Mr. Downie said he thought that the possesion of reliable analyses was a matter of great importance. Although the evidence of analyses was difficult to obtain, yet the very differences that Mr. Day had pointed out would point to different results if different classes or pigs of the same brand and under different conditions, and unless they had the analyses of the pigs used in those experiments, they could have no correct idea of the value of the Richardson process.

The President said that the quantities of sulphur and phosphorus in the iron made by the new process was about one-tenth of that in ordinary puddled iron; so that he did not think that such an immense diminution as that could be traced to the difference in the quality of the pig iron. He asked if Mr. Day could give them any idea of the point at which the phosphorus and sulphur became absorbed or dissipated from the iron. Was it at the time when the air was forced into the iron? The same process of injecting air was used in the Bessemer process, which, it was alleged, did not remove the phosphorus or sulphur, so that it could scarcely be at that point in the manufacture. Or were these elements taken away in the puddling process?

Mr. Day replied that the theory as to the removal of sulphur and phosphorus is, in its present state, incomplete. It was known that sulphides and phosphides of iron maintained a state of liquidity at a lower temperature than that at which the iron was formed into balls; this led Dr. Percy some years since to propound the view that when the granules of iron were collected into balls the phosphides were liquated or sweated out; and some experiments made at Woolwich by Professor Abel seemed to confirm this view. If this supposition of Dr. Percy's was correct, it lent great weight to the value of the Richardson process, because on account of the temperature of the furnace being higher the period of balling was necessarily longer, and in that case greater time was allowed for the liquating or sweating out of the sulphide and phosphide. One thing, however, was perfectly evident, that there was some influence at work with the Richardson process that was not present in so large a degree by the common process: it effected the removal of sulphur as well as phosphorus, as a reference to the analyses given in the paper would clearly show.

Mr. W. M. Neilson thought it would have been important if a drawing of the furnace where the experiments were made had been exhibited. He could not see how air blown in the same way could have a different effect in the Richardson from the Bessemer process. He would like to know what was the difference in the amount of coal used in the two processes.

Mr. Day replied that air was not blown in in the same way, at the same time, nor for so long a time, nor for the same object, in Richardson's as in Bessemer's process, and that a saving in fuel was effected by the Richardson process.

Mr. Neilson said it was well known that there was a considerable amount of sulphur given off by the coal in the furnace; and he suggested whether it might not in some degree account for the smaller quantity of sulphur found in iron made by the Richardson process that it was a shorter time than usual in the furnace. Also, might not the current of air which passed over the top of the coal in the furnace prevent the iron from imbibing the sulphur. It was rather a mysterious thing, and being so they could not exactly believe it. Probably if they got the drawing of the furnace, and more explanation of the perfect process, they would understand it better.

Mr. Beardmore said an ordinary reverberating puddling furnace was employed. The air was blown through the iron, near the bottom.

Mr. F. Kohn concurred with Mr. Day's statement, that the theory of the metallurgical processes now under consideration was not very perfect. There were, however, sufficient experimental data on record for forming at least an approach to an explanation of the difference of results obtained by the Bessemer and by the Richardson process. He would first of all refer to Mr. Neilson's remark about the supposed diminished absorption of sulphur from the coal in the puddling furnace. This explanation, although plausible in itself, would not suffice for explaining the actual removal of sulphur already contained in the pig iron before its being charged into the furnace, and which the experiments had shown to take place in such a large measure. Experiments had been made by Dr. Crace Calvert, of Manchester, Professor Wedding, of Berlin, and others, to ascertain at what period of the puddling process the sulphur and phosphorus were removed from the iron and driven into the slag. Samples of iron were taken out of the furnace during a charge in intervals of a few minutes, and particularly at those moments when any of the vital changes in the puddling process occurred. The analyses of those samples showed that the sulphur and phosphorus were removed principally during the early stages of the puddling process—that these elements combined with oxygen and formed sulphates and phosphates or salts, which formed a portion of the slag. It seemed probable from other experiments on record that, at a higher temperature, such as that which follows the "boil" in puddling, or such as existed in the Bessemer converter, the liquid iron in contact with the slag had the power again to reduce those salts from the slag, and to form sulphides and phosphides of iron. In the Bessemer process the whole liquid contents of the converter, including these sulphides and phosphides, are turned into the casting ladle, and finally into the ingot moulds themselves; there is therefore no opportunity given by this process for a separation of the metal from those noxious substances. In the puddling process the stage of "balling" affords such an opportunity. It is well known that the phosphides of iron are liquid at a much lower temperature than that at which wrought iron solidifies or "comes to nature," in the terms of the puddlers. It seems also likely that some sulphides of iron have a similar property. An experiment recently communicated to him by Mr. James Addie, of the Langloan Ironworks, appeared to give evidence on this point. In certain kinds of pigs a peculiar speck of a different colour from the rest of the iron had been noticed when fracturing the pig through its centre, this speck again occupying the centre of the fractured surface. Mr. Addie had a portion of this material drilled out of the centre of a pig, and the analysis showed that this portion contained a much greater percentage of sulphur than the rest of the iron taken from the same pig. This seemed to show that the pig iron solidified at a temperature at which the sulphides mixed with it remained liquid, and that these latter therefore accumulated in the centre of the solidifying mass, and remained liquid there until the temperature fell below their own point of solidification. Although it did not appear prudent to found a theory upon a single experiment, he believed that the general tendency of the evidence was in favour of the assumption that both sulphides and phosphides of iron remained liquid at the temperature of the balling process. Taking this for granted, it would appear that the mechanical process of balling, which consisted in collecting and pasting together the solid particles of iron, would effect a separation of the metal not only from the slag, but also from those liquid sulphides and phosphides; and the iron formed into a ball, and freed from the adhering liquid mass by the subsequent mechanical operations, would therefore contain only a proportionally small amount of sulphur and phosphorus. He did not hold up this attempt at an explanation as a precise and well-established theory, but he thought it at least sufficiently plausible to be of some utility in the present state of existing knowledge on this subject. He believed that Dr. Percy was the first to point out the peculiar function of the balling process in connection with the removal of sulphur and phosphorus from the iron.

Mr. Beardmore said they saved a quarter of an hour on each heat. The yield was about the same as by the ordinary process. The iron was very uniform and improved. Although they saved a quarter of an hour in each heat, yet the men would not give them more heats per day than previously. The tensile strength and the ductility were greater.

Mr. Day remarked that if the elongation was greater, that was a very important piece of information, as the *work* necessary to produce fracture showed at once a much higher value.

The President said it was very evident that when they came to compare one process with another, engineers did not look at the question from a chemical point so much as the mechanical—the question with them was what work the material would do; and it would be well if some experiments were made to bear upon that point in the matter before them.

Mr. J. M. Blair asked if the Richardson process would cheapen the price of iron? He expected, as one of the practical results of this new process (seeing that such a saving of time and fuel was effected), the price of iron would be reduced; but Mr. Beardmore did not seem to admit any appreciable saving.

Mr. Beardmore said an inferior pig iron could be used in the manufacture, which would tend to cheapen the process.

Mr. Day replied the correct answer to Mr. Blair's question was—that out of common pig iron, puddled iron was now made by the new process equally strong as with that hitherto made from the best brands, by the common method of puddling from the best pigs. Chemically speaking, the new iron is considerably purer than that made from the best pigs by the old process. The economy thus brought about was therefore unquestionable.

Mr. R. Douglas said he was not very conversant with the process of puddling; but to his mind it was not at all satisfactory that they should have statements so widely varying from Mr. Rowan and Mr. Day, as to the sulphur and phosphorus in Scotch pig iron, when the Richardson process claimed to accomplish largely the elimination of these elements. He would like to have analyses of the particular irons used in the various experiments.

Mr. Day stated that the mixtures under the experiments have been seven-eighths of No. 4 Scotch gray forge pig and one-eighth of red hematite, the chemical value of which, in respect of phosphorus and sulphur, could be found in the analyses given in the paper.

Mr. Downie concurred with a good deal that had been said in respect of those special experiments. He thought that, as a class, engineers had too long neglected to give due attention to chemistry; and he was of opinion that it would be well if the analyses of the iron experimented upon were added to the paper yet. Mr. Kohn had given them a theory of the manner of the change that took place in the iron, and if Mr. Beardmore could supply analyses of the iron he was using it would be of great importance. He looked upon the Richardson process as a great improvement upon the old system.

Mr. Day replied that, on account of the process being so recent, it had not been possible to collect together all the information desirable; and it must be remembered that by reason of the fact of the theory referring to the metallurgy of iron and steel being yet imperfect, it was difficult to produce an exhaustive explanation of such a subject at this early stage. No question, however, could remain as to the value of the great facts which had already been elicited.

INSTITUTION OF CIVIL ENGINEERS.

January 28, 1868.—The paper read was "On the Relation of the Fresh-water Floods of Rivers and Streams, to the areas and physical features of their basins; and on a Method of Classifying Rivers and Streams with reference to the magnitude of their Floods—proposed as a means of facilitating the investigation of the Laws of Drainage," by Lieutenant-Colonel P. P. L. O'Connell, R.E., Assoc. Inst. C.E.

After referring to what might be termed the first stage of natural surface drainage, subsequently carried on and completed by rills, streams, and rivers, the author observed that streams draining large areas were not subject to sudden floods caused by short smart showers; and that a lake, like the extension of the area of a drainage basin, was a moderator of the flood discharge resulting from a given rate of rainfall. There were other natural moderators which were more or less effective, as, for instance, a porous, absorbent soil, and the foliage of dense forests: but the latter had apparently the property, in some situations, of increasing the actual amount of rainfall, which counterbalanced its effect as a moderator of river floods. Snow might, according as it thawed slowly or rapidly, be a moderator or the reverse. Again, when a tributary in flood flowed into a large main river, the channel of the latter also acted as a moderator. If a series of natural basins could be found, increasing regularly in area, having physical features as to slope, soil &c., all tending in the same degree to discharge the rain falling on them, and if the distribution of the rain were the same in all these basins, then, doubtless, the rate of discharge in floods might be described graphically by some regular curve, the abscissæ of which would denote the area drained, and the ordinates the flood discharge per second. This curve would be concave to its base, and the tangent at its origin would have a value representing exactly the maximum rate of rainfall. Such, however, were the diversities of physical features in river basins, and in the distribution of rainfall in the world, that the search after the desired series of natural basins possessing exactly similar characteristics would probably be a vain one. This was to be regretted, for rivers small and great might alike be referred to some such curve, and classified as flood dischargers, according as they took up positions near to or distant from the curve.

To supply the place, as a classifier, of this unknown curve, the author suggested the use of the common parabola, as follows:—Let x, the abscissa of a point in the curve, represent the area in square miles drained by a river, and y, the ordinate of the same point, represent the number of cubic yards discharged per second by that river. Then, in the common parabola, $y = M\sqrt{x},$ where M might be termed the modulus of the river, or of its drainage basin, as a flood producer. When M was large, it would indicate that the physical features were such as to slope, soil, total amount and distribution of rainfall, as to give the river and its drainage basin a high place in the classification. When M was small, it would, on the contrary, show either that but little rain fell on the basin, or that it possessed some of those physical features which tended to moderate floods.

With the view of illustrating how far this method of classifying rivers as flood producers was likely to prove useful, reference was made to some facts respecting the Mississippi and its tributaries, as recorded in the Report on that river by Captain Humphreys and Lieutenant Abbot, which tended to show, in the author's opinion, that the method might be usefully, if cautiously, applied.

Certain exceptional cases of river floods were next alluded to, and regret was expressed that data, sufficiently extensive and accurate for the purpose of testing very rigidly any method of classification, had not yet been collected. The author had, however, prepared a table, exhibiting a few of the physical features of some of the principal rivers of North America, Europe, and India. This table gave the area of the drainage basin of each river in English square miles, the flood discharge of the river in cubic yards per second, with the name of the authority for this statement, the flood discharge of the river in cubic yards per second per square mile drained, and the values of M in each case. The facts so collected were also exhibited in diagrams. After commenting upon the range in the values of M thus recorded, was observed, that whereas in the case of large rivers, the parabola expressive of the relation between the area drained and the discharge per second might, without sensible error, be supposed to have its apex situated at the origin of the co-ordinates, in the case of small districts this supposition would lead to error. In the latter instance it became necessary to ascertain, at least approximately, what was the maximum rate at which rain fell in the district, and to place the origin of the co-ordinates at a point in the curve where the inclination of the tangent to the axis of x should correctly represent that maximum rate.

For the sake of illustration, it was assumed that a district existed in which the maximum rate of rainfall was 5 inches an hour, and the maximum value of the modulus M was 20. This required that the origin of the co-ordinates should be situated at a point in the parabola where its geometrical tangent was inclined to the axis of x, at an angle whose trigonometrical tangent was 120. If x' and y' were the rectangular co-ordinates of the curve, measured from this point, its equation was $y'=20\sqrt{x'-\frac{y'}{120}}$, the areas being measured in square miles, and the discharges in cubic yards per second. But as, for small districts, it would be more convenient to measure the areas in acres, and the discharge in cubic feet per second, the formula became, when adapted to these new measurements, $y'=21{\cdot}4\sqrt{x'-\frac{y'}{5}}$ very nearly, or after the solution of this quadratic equation,

$$y'=-45{\cdot}796+\sqrt{2097{\cdot}28+457{\cdot}96\,x'}.$$

A table, computed by this formula, was then given, showing the discharge in cubic feet per second from districts increasing in size from 10 acres to 5 square miles; and it was stated, while the discharge from an area of 10 acres represented a rainfall of 3·56 inches an hour, that from a district having an area of 5 square miles represented a rainfall of only ·36 of an inch. It was stated, that in rivers whose basins were by no means small, very extraordinary floods might occur in years not remarkable for large totals of rainfall; and in conclusion a few statements and quotations were given, as affording examples of flood moderators.

It was announced that the discussion, which had been commenced, would be resumed at the next meeting, Tuesday, February 4, after the reading of the following Paper, "Floods in the Nerbudda Valley: with remarks on Monsoon Floods in India generally," by Mr. A. C. Howden, Assoc. Inst. C.E.; and that the monthly ballot for members would take place at the same meeting.

FEBRUARY 4, 1868.—The paper read was on "Floods in the Nerbudda Valley; with remarks on Monsoon Floods in India generally," by Mr. A. C. Howden, Assoc. Inst. C.E.

This valley was described as being bounded on the north by the Vindhya and on the south by the Sautpoora ranges of mountains, and as consisting principally of black cotton soil, which was renowned for its fertility. The drainage of the valley supplied nearly the whole volume of the waters of the Nerbudda River, which traversed it in a direction nearly due east and west. The river took its rise in the Vindhya mountains, at an elevation of 3500 feet above the sea; its fall to Jubbulpore, 190 miles distant, was 10 feet per mile, and thence to the Gulf of Cambay the fall might be estimated at about 2 feet per mile; the total length of the river being 800 miles. The width at its source was only 1 yard, while a little above its confluence with the Towah, 360 miles down stream, it was 900 yards, and at its mouth upwards of 1 mile. In an ordinary monsoon the level of the water rose between 30 and 40 feet, but it had been known to rise nearly 60 feet, when it overflowed the banks. Midway between the river and the Sautpoora mountains, this valley for a length of about 270 miles was traversed by the north-eastern extension of the Great Indian Peninsula Railway, which crossed all the tributaries falling into the river on its southern bank; and it was the floods to which these feeders were liable that formed the subject of the present paper.

The floods of this region were divisible into two classes, according as they affected the plains or the rivers. With regard to the former, it was remarked that the greater part of the Nerbudda Valley traversed by the railway was almost a level plain; and that although the average rainfall in the district, 46 inches, or 11½ inches for each of the four monsoon months from June to September, could easily be provided for by the natural watercourses, yet that as much as 10·50 inches fell in eighteen hours in August, 1864, causing sudden and disastrous floods. It was observed that, in constructing a railway across plains of this description, great attention should be paid to the rainfall of the district, and ample provision should be made for carrying off the maximum amount speedily, without allowing it to dam up; as few embankments (especially those formed of black soil) could withstand the immense pressure then brought upon them, although the period of danger might not exceed twelve hours during the year, and should an opening once be formed, the scour was such that the embankment speedily melted away.

The principal rivers crossed by the railway in the Nerbudda Valley from Bhere to Bagra, a distance of 100 miles, were the Towah, Gungal, Matchock, Karlee Matchock, and the Snktha or Chota Towah, besides the Sconce Jamnee, Hurda, and other nullahs. The greatest flood known for ten or fourteen years, or according to native report for thirty years, occurred in 1864, when, on the 15th of August, the river Towah rose 47 feet in a few hours; and it was estimated that the velocity at the surface was 16·58 feet per second, the fall 4·25 feet per mile, and the discharge 976,629 cubic feet per minute. It had been asserted that the flood of 1864 was an unusual one, but that of 1865 was of a similar character; while the flood of 1866 exceeded its predecessors, both in force and magnitude. The next important river was the Gungal, the highest known flood in which took place on the 22nd of July, 1864, when with a fall of 3 feet per mile, the mean velocity from calculation being 166·14 inches per second, the discharge amounted to 732,123 cubic feet per minute. Two subsequent floods occurred in this river on the 8th and the 29th of August, 1866, and then, the fall being as before 3 feet per mile, the mean velocities were found to be from observation 153·68 and 110·22 inches per second respectively, the relative discharges being 477,820 and 109,494 cubic feet per second. Some idea of the force of the current in Indian rivers on such occasions might be gathered from the fact, that in a comparatively small river, 30 feet plate-girders had been carried 7 miles down stream; while in 1866 masses of masonry weighing 1600 tons and 1000 tons had been washed away from two of the piers of the Towah Viaduct, without a single stone being recovered.

In conclusion, the author expressed his opinion that, in bridging rivers of the description referred to, in the first place, wide spans were indispensable; for the current was so swift, and the rise of water so rapid after a heavy fall of rain, that any contraction of the waterway caused a dangerous scour and backing up. Secondly, he thought that next in importance to having as few piers as possible, was the necessity of giving them the greatest strength, by building them of solid block in course, set in cement. Thirdly, that the face of the cutwaters of piers should always be tool-dressed to reduce the friction, the 'bush' frequently left on forming an obstruction. And, fourthly, that when rubble backing was used, care should be taken in suspending work, to finish off below high-water level with a bed of solid block in course, as otherwise the water would penetrate the work, and speedily blow up the pier.

It was announced that the discussion upon Colonel O'Connell's paper on the "Fresh Water Floods of Rivers;" and upon Mr. Howden's Paper on "Floods in the Nerbudda Valley," would be continued at the next meeting, Tuesday, February 11, when the following paper would be read, "On the Supporting Power of Piles, and on the Pneumatic Process for Driving Iron Columns, as practised in America," by Mr. W. J. M'Alpine, M. Inst. C.E.

At the monthly ballot, the following candidates were balloted for and duly elected, as Members—John Wolfe Barry, James Craig, Charles Henry Denham, and David Reid Edgeworth; and, as Associates—Fritz Bernard Behr, Richard Broome, William Henry Clock, Frederick Charles Danvers, Edwin William De Rusett, Charles William Dixon, William Frederick Faviell, Alfred Francis John Fisher, John Henry Greener, Captain John Tunstall Haverfield, R.M.L.I., Captain William Robert Johnson, M.S.C., James Ouchterlony Macdonald, Thomas Boustead Nelson, Alfred Richard Cecil Selwyn, Lionel Henry Shirley, Arthur Telford Simpson, Henry Edward Thornton, and Thomas Walker.

A report was brought up from the Council stating that, under the provisions of Section IV. of the By-laws, the following candidates had been admitted since the last announcement Students of the Institution:—John Hopwood Blake, Joseph Cash, Raymond Edmiston, Malcolm Graham, Charles Edward Jones, James Verchild Ley, Morton Kelsall Peto, William Herbert Peto, Charles Edward Robinson, Arthur Toulmin Smith, Edward Herbert Stone, and Frank Napier Thorowgood.

ON OXYCHLORIDE OF ZINC AS A CEMENT.

By Dr. Tollens.

SORET has, as is well known, used the solid mass resulting from the mixture of chloride and oxide of zinc, more, however, in making small objects than as a cement. It has also been used for stopping teeth. This cement is admirably adapted for the laboratory; by its means a vessel may be closed perfectly air-tight in a very durable manner: thus a chlorine wash-bottle was for a quarter of a year in use without needing any repair. To attain this, however, care must be bestowed on its preparation and application. Commercial zinc-white is mixed with half its volume, or an equal weight, of fine sand, and rubbed in a mortar with solution of chloride of zinc of 1·26, so as to form a homogeneous paste, which is applied as quickly as possible. The weight of the solution required will be about the same as that of the oxide of zinc. If the solution is of this strength, there is time to apply it to the vessel, and, on setting, it will have an adequate degree of hardness; with a greater degree of concentration, the hardening proceeds too rapidly, while with a less the hardening is insufficient. The cork is pressed a little in the neck of the apparatus, so that there is a hollow space of two to three lines about the glass tube; after moistening this with the solution, it is filled up with cement, which is laid on a little round the tube. Owing to the rapid hardening of the oxychloride, the apparatus can be used a few minutes after. In disengaging chlorine, there is scarcely any annoyance from the gas, so that a change of workmen is not necessary, as was formerly the case. It may be used for many other purposes—cementing glass lutes in metal tubes, closing slits in metal apparatus, &c. The cost is not great; with less than an ounce of zinc-white, and the same quantity of sand and of solution, a pretty large wash-bottle may be made tight.—*Zeitschrift für Chemie.*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

SOME REMARKS ON CRYSTALS CONTAINING FLUID.

By J. B. Dancer, F.R.A.S.

THE author gave a brief history of the discovery of fluids in crystals, including Sir H. Davy's chemical experiments on the fluids and gases obtained from the cavities in quartz crystals; Sir David Brewster's discovery of the pressure cavities in the diamond, ruby, emerald, amethyst, chrysoberyl, &c.; the existence of minute crystals in these cavities, and the two new and remarkable fluids, which are immiscible, but sometimes found together in the same cavity—one a liquid hydro-carbon, named Brewstoline, the other Cryptoline; his experiments and examination of artificial crystals deposited from aqueous solutions; his examination of the Koh-i-noor diamond and others in the East India Company's museum; and the geological speculations to which these discoveries gave rise. Mr. Dancer mentioned the experiments of his late father and others in producing artificial gems by intense heat, and stated that his own attention was drawn to this subject some twenty-four years since, by Sir David Brewster presenting him with a specimen of topaz containing fluid. Since that time he had examined a large number of crystals, of various kinds, from the collections of friends; and had found fluid in quartz from South America, Norway, the Alps, Ireland, Snowdon, and the Isle of Man; and in fluor spar from Derbyshire; this latter specimen contained a considerable quantity of fluid, which burst the crystal at 180° temperature.* He suggested the employment of the microscope as a valuable assistance in detecting spurious from real gems; very few of the latter are perfect, and the flaws and cavities are so distinct in character from those which are so abundant generally in artificial gems that very little experience is sufficient for the purpose. This mode of testing of course is limited to transparent crystals, but might be employed when the usual methods are not practicable. He also mentioned Mr. Sorby's (F.R.S.) discovery of fluid cavities in the quartz of granite, in the quartz of volcanic rocks, and also in the feldspar ejected from the crater of Vesuvius, and Mr. Sorby's method of determining the temperature at which various rocks and minerals are formed.

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*After this paper was written, Sir David Brewster informed the author that the fluid contained in crystals of fluor spar was water, and that the cavities burst at a temperature of 150°.

INSTITUTION OF MECHANICAL ENGINEERS.

DESCRIPTION OF THE PAYING-OUT AND PICKING-UP MACHINERY EMPLOYED IN LAYING THE ATLANTIC TELEGRAPH CABLE.

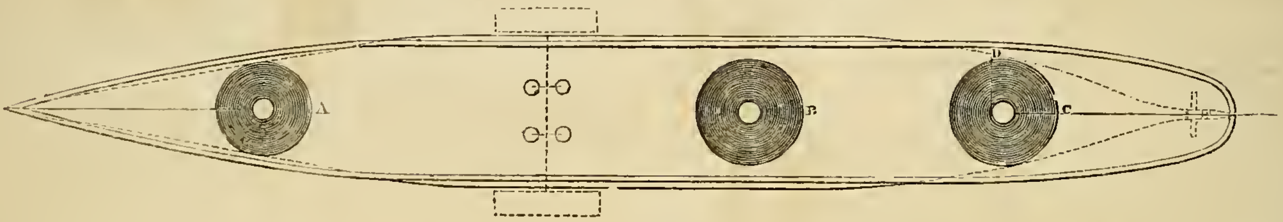
By Mr. George Elliot, of London.

The Atlantic Telegraph Cable expedition of 1866 was twofold in its purpose, the first object being to lay a new cable, and the second to recover and complete the one commenced and lost in the unsuccessful attempt of the previous year. The general arrangements on board the *Great Eastern* steamship, which was employed for the purpose on both occasions, were similar in both years; but the knowledge and experience which had been so dearly bought in 1865 rendered necessary many improvements and alterations in the detail of the apparatus employed.

The cable itself was coiled in three circular wrought-iron tanks, which were built on the main deck of the ship, as shown in figs. 1, 2, and 3, which represent a general plan and longitudinal and transverse sections of the vessel. The foremost tank, A, occupied the space which had previously been the forecargo space; and the after tank, C, was placed in what had been the aftercargo space. The middle tank, B, occupied what had been the second dining saloon; and the funnel (shown by the dotted lines in fig. 2) from the pair of boilers in that position was removed for the purpose, those boilers being thrown out of work during the expedition. The whole of the fittings in these spaces had been removed, and each of the tanks was stayed to the sides of the ship by two flat frames of iron, built on angle-iron framing, thus securing the tanks in the most substantial manner. The deck had also been shored underneath by baulk timbers, which were carried through from deck to deck down to the bottom of the ship.

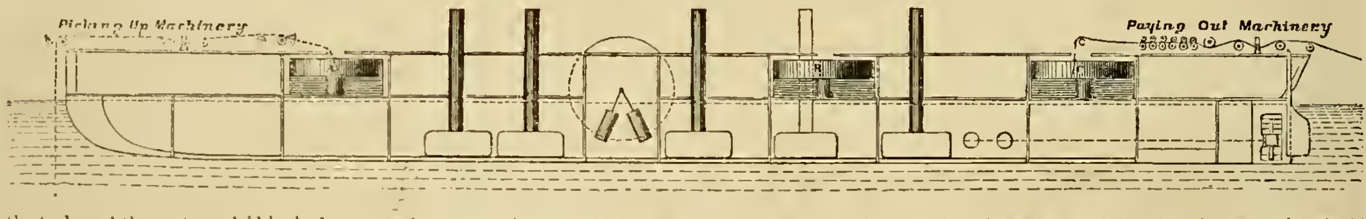
The fore tank was 51 feet 6 inches diameter, the middle tank 58 feet 6 inches, and the after tank 58 feet; they were all of a uniform depth of 20 feet 6 inches, and similarly constructed in all respects. The bottoms were $\frac{1}{2}$ inch thick, lap-jointed; and the sides were $\frac{5}{8}$ inch thick in the lower half, and $\frac{1}{2}$ inch in the upper half. The sides were butt-jointed, so as to present a perfectly smooth surface inside; and the bottoms were covered with a thin wood floor to receive the cable. As it was of vital importance that the cable should be kept always under water, to prevent depreciation of the gutta-percha coating, and also to afford the only means of effectually testing its electrical condition, these tanks were carefully made water-tight. In paying out the cable, the water in the tanks was kept somewhat below the level of the top flake, and required to be lowered during the paying out; for this purpose each tank was supplied with discharge valves, and as the bottoms of the coils were above the water line of the ship, as shown in fig. 2, it was only necessary to open these valves in order to allow the tanks to discharge themselves completely.

Fig. 1.—Plan of *Great Eastern*, containing Cable and Machinery.



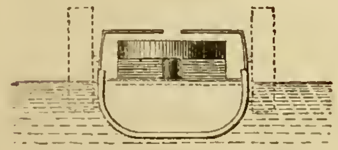
The coiling of the cable into the tanks, out of the hulks by which it was brought from the Telegraph Construction and Maintenance Works at Greenwich to the *Great Eastern* at Sheerness, was effected in the following manner:—The cable was brought up over the side of the ship from the hulk, upon wheels which guided it on to a large deep-grooved wheel driven by steam power; on the tread of this wheel ran a small jockey wheel or roller, pressing the cable down into the groove of the large wheel, so as to give sufficient friction for enabling the wheel to draw up the cable from the hulk. The coiling commenced from the outside of the tank, the end being previously triced up above the tank, leaving a clear end for splicing and testing. The first turn of the cable was carefully laid round the outside of the tank, and the next was laid back close up against the previous turn, and so on until a perfectly flat flake or layer was laid into the eye of the coil, which was left about 9 feet 6 inches diameter. The cable was then led out direct to the outside of the tank, across the coils already laid; and another flake was commenced precisely similar to the first, this process being continued until the tank was filled.

Fig. 2.—Longitudinal Section.



The direction of lay-out of the cable from the end of one flake to the beginning of the next was tangential to the circle of the eye of the coil, as shown at D, fig. 1; and the portion of cable crossing the coils was protected from the weight of the coils above by wood battens laid on each side of it, about 3 inches wide and 1 inch thick with the edges rounded. When the coiling down of the cable into the tanks was finished, eyes were fitted into the centre of each coil, which were telescopic in their construction, so that as the cable was paid out the eyes could be lowered from time to time. Men were stationed in the tanks for the purpose of keeping the cable always clear during the paying out.

Fig. 3.—Transverse Section.



In paying out the cable it was passed up to the hatch over the centre of the coil, and carried over a large wheel, E, about 4 feet diameter, as shown in the enlarged longitudinal section, fig. 4. The cable was then carried in a trough, F, about 2 feet wide, made of sheet-iron, leading to the paying-out machinery; this trough was fitted with rollers at about 10 or 12 feet intervals to relieve the cable from friction in passing along, until it reached the paying-out machinery, which was placed in the stern of the ship, slightly to the port side.

The length of cable in the after tank was 840 knots (1 knot = 6084 feet = 1·15 statute mile), in the middle tank 865 knots, and in the fore tank 671 knots; and the entire length of 2376 knots was joined up into one continuous length of cable before the laying was commenced. The size of the cable was $1\frac{1}{8}$ inch diameter, and its weight 31 cwts. per knot in air, and $14\frac{3}{4}$ cwts. per knot when immersed in water; the breaking strain was 8·10 tons, equal to eleven times its weight in water per knot, so that the cable would just bear its own weight in 11 knots depth of water.

Paying-out Machinery.—In the paying-out machinery the chief object to be attained was to supply some means of checking the cable in the most regular manner possible while passing out of the ship, and also of keeping it in a state of constant tension; and it was required that the amount of this tension should be at all times known, and that it should be regulated by the depth of the water in each particular part of the ocean, and also, to some extent, by the speed of the ship.

Fig. 4.—General Arrangement of Paying-out Machinery at stern of *Great Eastern*.

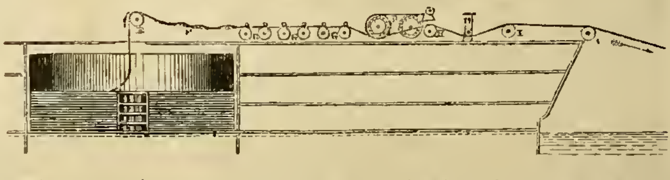
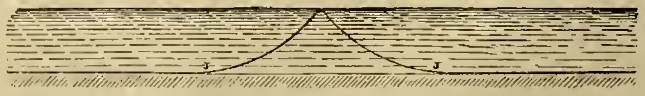
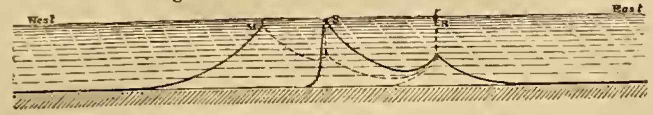


Fig. 5.—Theoretical Picking-Up of Cable in Single Bight.



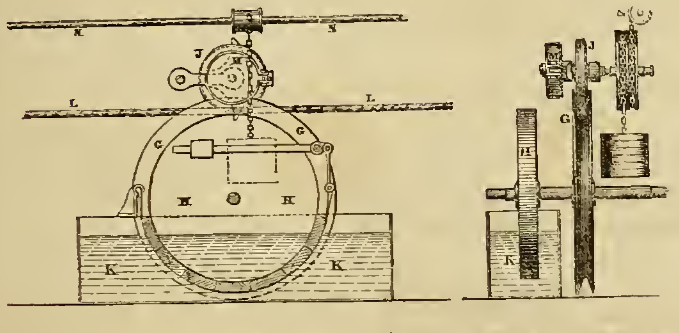
The most important feature is the arrangement by which it was rendered impossible that more than a certain strain should be kept upon the cable during the paying out. A less strain would only involve a slight loss of cable; but any increased strain might possibly damage or even destroy it. The cable on entering the paying-out machinery was passed over a series of six deep-grooved wheels, each about 3 feet diameter, one of which is shown in side and end elevation at G, in figs. 7 and 8. On the shaft of each wheel, G, was fixed a friction wheel, H, of the same diameter, to which was fitted a friction strap lined with wood and tightened by a weight on a lever, as shown in fig. 7; to prevent any unnecessary wear, this friction wheel ran in a tank of water, K. Above each of the grooved carrying wheels was a jockey wheel, J, about 14 inches diameter, pressing the cable, L, down into the groove of the carrying wheel, G, and hooped with an india-rubber tyre to form a soft cushion, so that no damage might be done to the cable. The jockey wheel was also fitted with a small friction wheel, M, having a wrought-iron strap adjustable by a screw. Any one of the jockey wheels could be lifted up, so as to allow the cable to slip freely through the groove in the carrying wheel; or in case of necessity the whole set of jockey wheels could be raised at once by a man stationed at a large band wheel, like an ordinary ship's steering wheel, turning the longitudinal shaft, N, which lifted up each jockey wheel by a chain winding upon the shaft. In practice there were generally about four of these wheels kept at work, but the machine was made with six in case of need.

Fig. 6.—Actual Picking-Up of 1865 Cable.



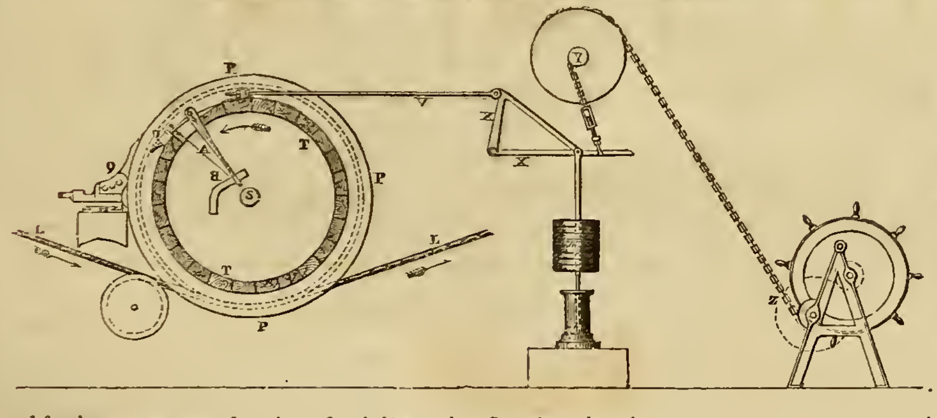
Paying-out Jockey Gear.

Fig. 7.—Side Elevation. Fig. 8.—End Elevation.



After the cable had passed through this part of the machinery, called for distinction the jockey gear, and had thereby been subjected to a slight amount of strain, it was led to the main paying-out drum, P, shown in side elevation in fig. 9, and in end elevation in fig. 10. The cable, L, entered on the underside of the drum, fig. 9, and was passed four times round, as a rope is passed round a capstan, and for the same purpose of getting a firm hold upon it. Just above the point at which the cable was led on, a knife-guide, Q, was placed for fleeting or slipping sideways the coils already on the drum, so as to leave a clear lead-on for the fresh cable; this guide was adjustable in both directions with screws, like a slide-rest on a lathe. The shaft, S, of the drum was carried through on each side, one end being fitted with a coupling, R, which will be referred to afterwards in connection with the picking-up arrangements adapted to this machine; and on the other end were fitted the main friction breaks, T T.

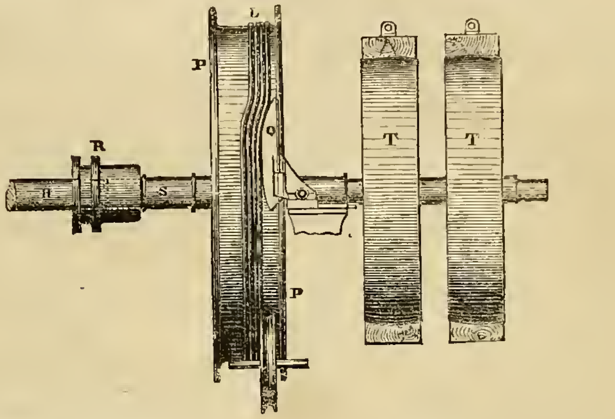
Fig. 9—Side Elevation of Paying-Out Drum and Friction Breaks.



These self-adjusting friction breaks were invented by the late Mr. Appold, and it is interesting to note that they were the identical breaks used in the first attempt to lay the Atlantic cable in 1857. The break wheels themselves, T T, figs. 9 and 10, of which there were two on the shaft, were 4 feet 6 inches diameter, and 12 inches wide on the tread, which was turned a little convex. On each wheel was fitted a wrought-iron strap lined with wood, and a screw adjustment, U, admitted of any required amount of friction being obtained. On the top of each break strap was a lug, to which a long rod, V, was fastened, leading to the top of a bell-crank lever, X, with arms in the proportion of 1½ to 1; and to the long arm of this lever was suspended a rod carrying a number of weights, W, which were removable at pleasure for adjusting the strain. The rod was continued below the weights, and had a piston attached to it working loosely in a water cylinder, to prevent any sudden jerking action from coming on the break. By screwing up the adjustment, U, the break was made to have sufficient friction for lifting the weights on the suspension rod.

In order to render the break self-adjusting, so that it should relieve itself whenever binding too hard, the break strap was cut through, and the ends were attached to a lever, A, in the manner shown in fig. 9, the lower extremity of the lever being free to move in a slot cut in the stationary bracket, B. When the break was binding too hard, so that it began to lift the weight, W, too high, the break strap consequently travelled round and brought the lever, A, into the position shown dotted. The attachment of the one end of the break strap at the extremity of the lever moved them through an arc of a larger radius than the attachment of the other end of the strap; and the result was therefore equivalent to lengthening the break strap and slackening the break off the surface of the wheel, causing the weight, W, to fall back instantly to its original position. The consequence of this action was that when the break was at work the lever, A, kept the strap just tight, and the weight, W, continued just oscillating. The two break wheels, T T, placed side by side on the drum shaft, fig. 10, were both fitted precisely alike throughout.

Fig. 10.—End Elevation of Paying-Out Drum and Friction Breaks.



Near the end of the bell-crank lever, X, fig. 9, a chain was attached leading to a wheel, Y, overhead; and from a larger wheel on the same shaft another chain led to a barrel on a winch, Z. A man standing at this winch by turning the hand-wheel could immediately take all the weight off the breaks, T T. The whole of this paying-out machine was made double, so that in case of any mishap there might be no delay, but the cable might at once be removed from one drum to the other. This provision, however, fortunately proved to be needless, as throughout the expedition there was no failure in any part of the machinery, its action having been in every particular perfect.

The cable having by these means been sufficiently checked, was passed over the stern wheel, A, fig. 4, into the sea; and on its way the actual strain was measured by a dynamometer placed at D, consisting of the following arrangement:—Immediately on the cable leaving the paying-out drum, P, it passed over a wheel, H; and at a distance of 23 feet 6 inches, over another similar wheel, I; and in the centre between these two wheels the dynamometer, D, was fixed, which is shown in figs. 11 and 12. It consisted of a wheel, D, weighted to a particular amount and riding upon the cable, L, being guided in a fixed vertical frame by rollers, A A. The amount of deflection evidently varies according to the strain on the cable, and the strain was calculated from the formula obtained by the ordinary resolution of forces, namely $S = \frac{l}{4d} W$ approximately; where S = strain, and W = weight of dynamometer wheel, D, both in the same terms; l = distance between centres of carrying wheels, H and I, fig. 4, and d = deflection of cable. The values of d or the amounts of deflection were calculated for all strains, from 7 cwts. up to 40 cwts., and a scale, B, was affixed to the instrument with an index, C, carried upon the wheel, D; so that the strain could immediately be read off at all times by simple inspection. The total weight of the wheel, D, and its suspended weight, F, was 426 lbs.; and the rod carrying the weight, F, was continued down to a piston, G, working freely in a cylinder of water, to prevent any sudden jerks of the dynamometer. The ordinary strain in paying out was found to vary from 10 to 12 or 14 cwts., and at no time exceeded 16 cwts.

(*To be continued.*)

MONTHLY NOTES.

Agricultural Exhibition at Brussels.—The Société Agricole of Brabant announces a great exhibition of cattle and implements, to take place in Brussels in the middle of the month of June next. The mechanical portion of the exhibition is to be universal. By a royal decree there is to be a lottery established for the purchase of implements, which are to be distributed by lot amongst the subscribers. This is, we believe, the first time that a lottery has been established in the interest of agriculture.

Paris Exhibition: Steam Plough.—M. Lotz, jun., who is the inventor of an excellent traction engine, has introduced a simple system of steam ploughing. Fig. 1 of the accompanying engravings is a perspective view of the plough; fig. 2 represents the engine employed, and fig. 3 is the anchor windlass. The engine, shown in fig. 2, is self-moving, and is placed at one end of the field to be ploughed; the anchor windlass is placed (fig. 3) at the opposite end. Two revolving drums are disposed round the boiler, each of which rolls on eight antifriction rollers; and motion is transmitted to one or other of these drums by means of pinions loosely mounted on a shaft underneath, parallel with the axis of the boiler, either of which may be thrown into gear by the motion of a hand lever when desired. On these drums are wound iron wire ropes, one of which is hooked on to the plough, and the other is passed over the windlass at the other end of the field, and its end brought back and secured by another hook to the plough. When, by means of the pinion, motion is transmitted to the drum, the rope of which passes over the windlass, the rope on that drum is wound round it, the plough drawn across the field, and the rope on the loose drum unwound by the same operation. On the arrival of the plough at the end of the field where the anchor-windlass is situate, a signal is given, and the machine is thrown out of gear, and the two drums rendered immovable. The ploughman then pivots the plough on its axis, so that its other end enters the earth; and another signal being given, motion is imparted to the bobbin which was before loose, and the plough is drawn back to the engine, and this operation is repeated until the whole field is ploughed. Whilst the plough is proceeding towards the anchor-windlass, and without stopping its progress, the engine moves the requisite distance, and the anchor-windlass, which is mounted on small wheels, also moves an equal distance during the return motion of the plough. This motion of the anchor-windlass is effected by a man constantly in attendance, and who assists the ploughman in turning the plough. The ploughman is seated at the end of the plough, and holds in his hand a lever, which acts on the axis of the wheels so as to render it more or less oblique, in order to accurately guide the direction of the plough.

Fig. 1.

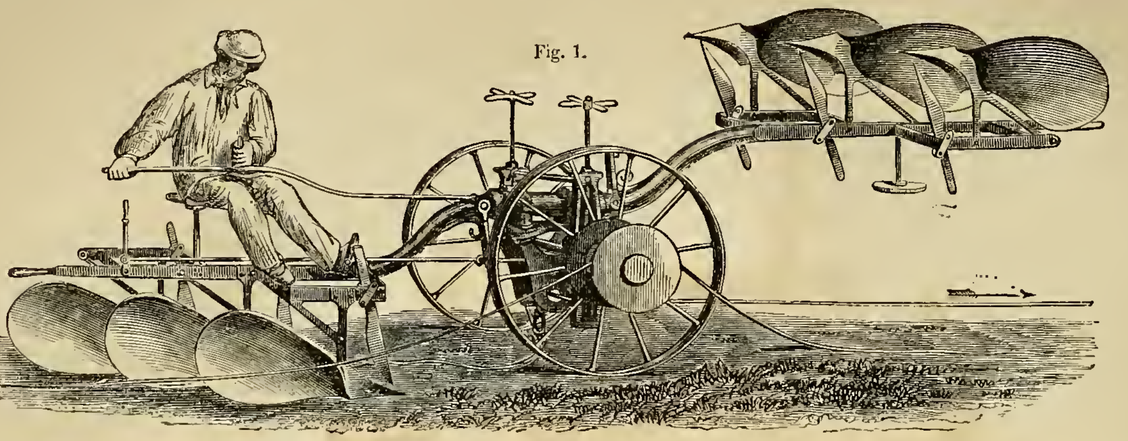


Fig. 2.

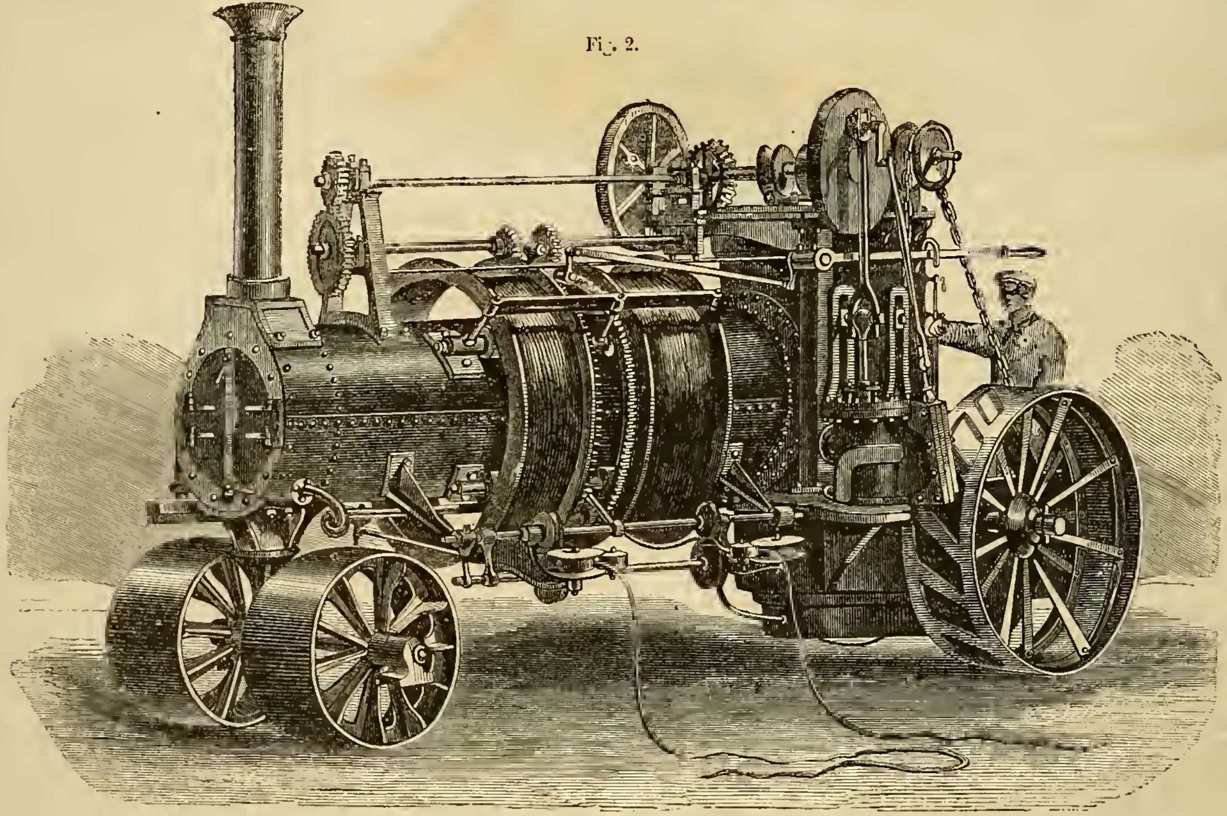
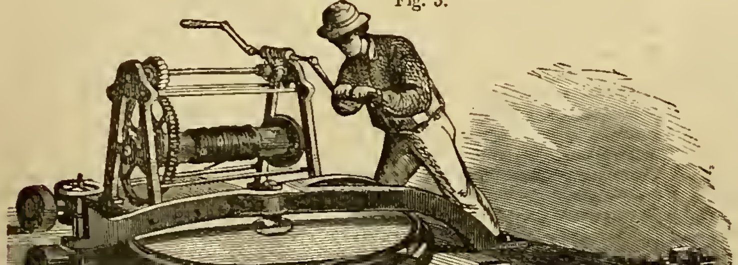
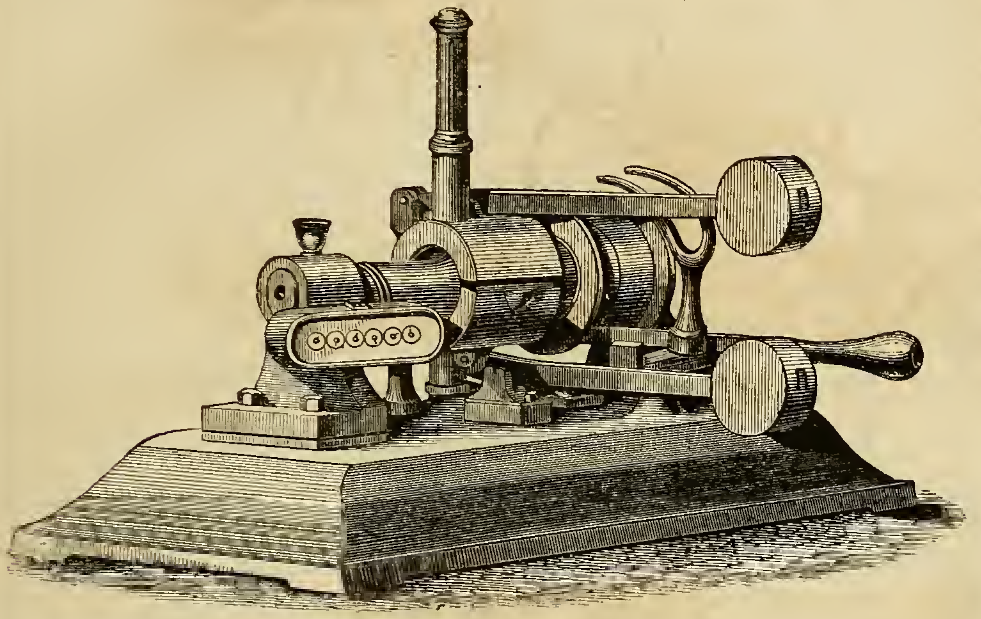


Fig. 3.



A Big Ditch.—The progressive people of Wood County, Ohio, are digging a ditch $37\frac{1}{2}$ miles long, 18 to 20 feet wide on the bottom, 30 to 40 feet on the top, and from 2 to 6 feet deep. It has a fall of $67\frac{1}{2}$ feet, or less than 2 feet to the mile. It will drain 60,000 acres of the "Black Swamp," and bring them into cultivation.—*American Artizan.*

Ingram and Stapfer's Oil Tester.—The accompanying illustration represents an ingenious contrivance which is now making rapid way under the auspices of Messrs. John Bailey & Co., of the Albion Works, Salford, Lancashire, who are, we believe, the sole manufacturers. Messrs. Ingram & Stapfer's patent apparatus is based on the well-known fact that all lubricants reduce friction or heat in rubbing or working surfaces in proportion to their quality as a lubricant; consequently that lubricant which will permit of the greatest number of revolutions being made by a shaft with the least heating of the bearings, must be the most serviceable. The instrument for ascertaining the above result consists of a pair of fast and loose pulleys mounted on a spindle carried in brass bearings on a bedplate. Motion is obtained by a driving strap guided by a fork, and a given amount of friction is produced by weighted levers, an indicator showing the number of revolutions, whilst a thermometer gives the temperature produced. If of two oils the one will allow of say 1000 revolutions being made before the temperature reaches 100°, the other sample gives 2000 revolutions before a temperature of 100° is attained, it follows that the second oil is twice as valuable as the first. Or the relative value of the oils tested may be ascertained by driving the machine to a higher temperature and comparing the quality of the residuum of each oil. This apparatus is equally applicable to the testing of oil for quick or slow moving machinery, it being simply necessary to drive the spindle either at a high or low speed accordingly, and to increase the friction by adjusting the weights on the levers in proportion as the speed is reduced. This apparatus will be found of the greatest service to oil consumers; we recommend it with the greatest confidence to their notice.



Technical Education in France.—The minister of the Marine and of the Colonies has just issued an order relating to what are called the Schools of Maistrance, in which a certain number of workmen in the arsenals and dockyards, chosen by competition, receive such special theoretical instruction as fits them for foremen or heads of shops. These schools were reconstructed by decree in 1851, but the progress made since that time in industrial science and training having left these schools in arrear, the minister has caused an examination and report to be made upon them. The result is that a decree has been issued establishing preparatory Schools of Maistrance in each of the government yards and arsenals of Cherbourg, Brest, Lorient, Rochefort, and Toulon, and also a school at the imperial establishment of Indret, for the theoretical instruction of a certain number of workmen. In addition to these, two normal Schools of Maistrance are established, one at Brest, and the other at Toulon. All of these schools are placed under the charge of the department of the director of Naval Construction. The old pépinière of the Luxembourg Gardens, which contained the finest collection of vines in France, and a large number of other plants, has been swept away, to the great regret of professors and students in botany and arboriculture; but the chief gardener of the Luxembourg, M. Auguste Rivière, still continues his public instruction on the pruning of fruit trees; the lectures, which commenced on the 21st of last month, are given under a tent in the transformed garden on three mornings in the week.

Quicksilver Mines in Italy.—In Tuscany there are four mines of quicksilver, but at the present time three have been abandoned on account of the low price now obtained for this metal. The only mine now worked is that of Siele, near Castelazara. The quantity of ore extracted in 1864 was 3000 quintals (300 tons), which yielded from 2 to 2½ per cent. of quicksilver—about 6000 kils. Quicksilver is also found in the neighbourhood of Agordo, in the Venetian provinces. The veins of sulphide of mercury are said to be most extensive, but are worked on a very small scale. The following is the annual produce of quicksilver in Italy:—

Mines.	Quintals.	Value.
Castelazara,	3,000	3,600 francs.
Agordo,	44,608	53,000 "
Smelting Works.		
Castelazara,	66	34,200 "
Agordo,	230	91,840 "

From 1863 to 1865 the imports of quicksilver were 10,900 kils., of the value of 71,100 francs; and the exports 1000 kils., of the value of 2700 francs.

Science and Industry in Russia.—The Russian Society of Acclimatization announces a second exhibition for the encouragement of agriculture, to open at Moscow on the 27th of July, and to close on the 16th of August in the present year. The society offers a considerable number of gold, silver, and bronze medals. The council of the University of Moscow has determined on the creation of an industrial museum, to be opened gratis on Sundays. The professors of the University propose also to establish courses of lectures on the applications of science to industry, and on the apparatus and implements to be found in the new museum. The Agronomic Society of Moscow has now under discussion the formation of an agricultural museum. The Russian Geographic Society continues to exhibit much activity. At one of its recent meetings Mr. Lerch gave a detailed account of his recent visit to Central Asia, and especially concerning the ruins of Djankend and Sauran, and Mr. Prioroff presented drawings which he had made of remarkable objects found in the ruins of Djankend. An account was also read of the Witim expedition, undertaken for the discovery of a practical route between Nertschinsk and the goldfields of the basin of the Léna; besides the chief results in view, the commission is occupied with geological observations, and has also sent home a rich collection of plants and birds. The commission, under Mr. Daniloff, appointed to visit the northern coasts of the Sea of Azoff, and to study the formation of the sandbanks, and the effect of water on the higher banks, has completed its work. The society has established branches at Vilna and Orenbourg. The port of Odessa was free of ice on the 5th of February, and the arrival of three steamers ordered by the Society of Commerce and Navigation for the transport of the anthracite extracted from the mines of the Don, was expected. The following is the official account of the quantities of gold furnished by the Government of Jenissëisk during the years 1861 to 1866 inclusive, and of the number of workmen engaged in the workings:—

	Gold pouds.*	Workmen.
1861	605	16,375
1862	559	18,640
1863	557	14,370
1864	499	15,995
1865	487	13,800
1866	482	13,900

* A poud is rather more than 36 lbs. English.

Armour-Plate Trials.—Trials of armour plates, of Sheffield manufacture, took place last week on board the *Thunderer.* Those under trial were selected by the Admiralty inspector, Mr. J. Luke, from a number at the rolling mills of Messrs. Charles Cammell and Co., Cyclops Steel and Iron Works, and comprised an 8-inch plate, for the colonial turret ship *Cerberus*, building at the Palmer Shipbuilding Company's Works at Jarrow-on Tyne, and a 6-inch plate for the second-class armoured frigate *Audacious*, building by the Messrs. Napier, of Glasgow. They were tested under the superintendence of Captain A. H. Hood, C.B., commanding her Majesty's ship *Excellent* and the gunnery establishment at Portsmouth, Mr. George Wilson, of Sheffield, representing the makers. The 8-inch plate measured 12 feet in length by 3 feet 6 inches in width, and was struck by nine shots within an area of 32 inches across the breadth of the plate and 18½ inches longitudinally; maximum indent 1·6 inch, minimum ditto 1·5 inch. Two shots fell on the edge of a bolt without doing any injury; and the result of the total pounding only brought out slight surface cracks within the area of the indentations. On the plate being unbolted and taken down from the proof butts its reverse side exhibited favourable results, the greatest amount of bulge being only 2⅜ inches, and all the openings in the metal being longitudinal. The 6-inch plate measured 16 feet 7 inches by 3 feet 8 inches, and was struck by five shots, in the usual quadrilateral form, within an area of 19 inches square. No damage on the obverse side of the plate was done outside the area of the shot indentations. The maximum indentation was 2·1 inches, and the minimum 1·9 inches. On removing the plate from the proof butt the reverse side was found to have only longitudinal openings, but the plate, although undoubtedly one of good character, was softer in metal than the average of plates are found on trial, the extent of the bulge being 3⅞ inches. It is the opinion of many engaged in the working of iron, that iron of a softened quality, as compared with the quality of the iron of which the majority of our armour-plates are at present made, would very materially improve their lasting powers under fire, as compared with the present average lives of the possibly over-hardened thick plates, and insure them a high classification on testing in cases where they now often receive a low one.

Changes in the Gulf Stream.—While many have amused themselves with speculations about the cause of the late earthquakes and violent elemental disturbances in the West Indies, we are likely to be made aware before long of some of their apparent results. Since these occurrences the current of the Gulf Stream has been observed to have nearly doubled its velocity, not only increasing the dangers of navigation among the islands and off the Florida Keys, even for steam vessels, but awakening apprehensions of still greater and more important general changes. The climatic effect of this huge hot-water stream along the North European and American coasts is rarely realized. But the fact that the British Isles are in the same latitude with icy Labrador, will show what it does for our cousins, and suggest what terrible changes might be brought about by a shift in the direction of its current—which might as easily take place as increase in its velocity.—*New York Times.*

Keyless Watches.—Mr. Adolph Cohen, of Birmingham, has recently (20th August, 1867) patented a very ingenious arrangement for winding up the mainspring of this class of watches, and also for setting the hands or pointers. Referring to the engravings, fig. 1 represents an internal view of a hunting watch with the cover removed, showing the hinge and mechanism connected therewith in readiness for winding up the mainspring, by the closing of the case, and also the movable stud or pin for effecting the adjustment of the hands, such pin being represented as protruding beyond the case, or in a position in readiness for turning the hands. A is the case of the watch, and B is the hinge of the front cover. This hinge has a short arm, *a*, projecting therefrom. To the arm, *a*, there is jointed a link, C, which is again jointed to the intermediate piece, D, connected by a pin joint to the horizontal lever, E. The object of this intermediate piece is to form a species of universal joint, which will accommodate itself to the movements of the lever, E, and the link, C, respectively; for which purpose the two joint pins, *b* and *c*, are situate at right angles, the one, *b*, in the link, C, being horizontal, whilst the other, *c*, in the lever, E, is vertical. The lever, E, works on a fixed centre, *d*, at one end, and has jointed to its opposite end by a pin, *e*, the curved rack, F, the teeth of which gear into those of the ratchet wheel, G, fast on the arbor of the mainspring. The teeth in the ratchet wheel, G, are so inclined relatively to those in the rack, F, that the rack will only engage or gear with the wheel, G, and turn the same when moving in the direction of the arrow; but will slip over the ratchet wheel teeth without turning the wheel when it is moving in the reverse direction. In order to keep the rack in contact with the teeth of the wheel, G, a small projection or tail-piece, *f*, is formed on the jointed end of the rack, which is acted upon by the blade-spring, *g*, secured to the lever, E. H is a fixed plate which bears upon the surface of the lever, E, for the purpose of preventing the lever, E, from rising. I is a friction plate, let into the plate, K, to prevent any rubbing of the latter by the sliding link, C, intermediate piece, D, and lever, E. The ratchet wheel, G, is prevented from turning accidentally during the passage of the rack teeth over it by the spring detent, L, which allows the wheel to revolve freely, however, when the rack is moving in the direction of the arrow. The hinge, B, being in the position shown in black lines when the front case is open, it follows that on shutting down or closing the case the arm, *a*, of the hinge will assume the position, drawing with it the link, C, lever, E, and rack, F, in the direction of the arrow, and imparting thereby about half a revolution to the ratchet wheel, G, and winding up the mainspring to a certain extent. On opening the case or cover the reverse motion takes place, the rack, F, passing freely over the teeth of the wheel, G, and assuming the position shown in fig. 1, in readiness for a further action upon the spring when the case is closed again. In order to prevent the overwinding of the mainspring it is proposed to connect it to an intermediate friction ring or bridle, M (shown clearly in the detail of the barrel, fig. 2), in lieu of attaching it directly to the barrel itself. This ring, M, is by preference split or open, its two ends being made to overlap at *h*, so as to allow it to expand and fit the interior of the barrel, N, with sufficient friction to drive the works, and yet to turn freely inside the barrel when the spring is fully wound up. *i* is the hook or catch by which the outer end of the mainspring is attached to the friction ring or bridle, M.

Fig. 1.

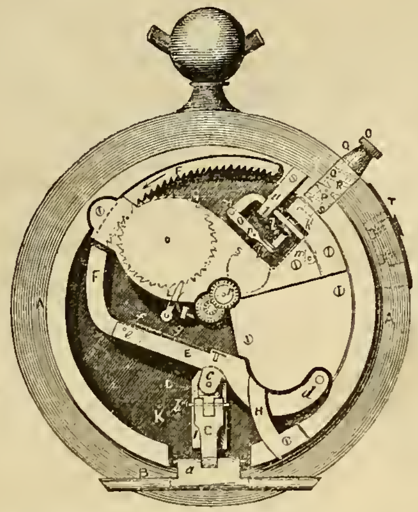
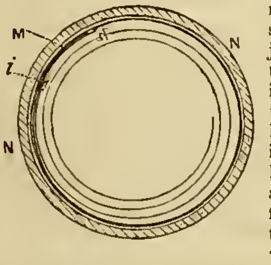


Fig. 2.



Sale of the Late Paris Exhibition Building.—The iron portion of the building in the Champs Elysées has been sold to a company of contractors, for the sum of £60,000; it is not yet known what is to be its future destination.

The Chilian gun now being built at Pittsburg is 22¼ feet in length, being 2 feet longer than the famous Rodman gun at Fort Hamilton, but of exactly the same bore, 20 inches. Its greatest diameter is 5 feet 4 inches, its least diameter 2 feet 9 inches. The gun is designed for garrison or naval service.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

5th February, 1868.

387 T. W. Walker, Poole—Bricks
388 R. D. M'Kellen, Manchester—Cotton
389 S. G. Taylor, Tyldesley—Lubricating the spindles of machines
390 R. J. Jones, Blue Pits—Clog soles
391 F. Ardache, Saint Vaast—Winding flat cords
392 M. P. W. Boulton, Tew Park—Aerial locomotion
393 H. Bunning, New Cross—Burning combustible liquids in furnaces
394 W. E. Newton, Chancery Lane—Mowing and reaping machines.—A com.
395 W. E. Newton, Chancery Lane—Buttons.—A com.
396 H. Moore and J. Hamilton, Aston—Furniture expanders
397 J. A. Jones, Middlesborough—Iron and steel
398 J. Hay, Glasgow—Horse shoes

6th February, 1868.

399 C. W. Guttbridge, Landport—Cutting soap
400 G. Roper, Aylesham—Screw propeller.—A com.
401 A. E. Borgen, Seething Lane—"Phosphor free" matches.—A com.
402 W. J. M. Rankine and J. M. Gale, Glasgow—Condensing steam
403 H. Brindle, Leyland—Shuttles
404 J. Honeyman, Glasgow—Trapping and ventilating
405 W. E. Newton, Chancery Lane—Steam-gauges.—A com.
406 J. C. Cole, Smethwick—Drill braces
407 J. T. White, King Edward Street—Fire-lighters
408 G. F. Bradbury and T. Chadwick, Oldham—Sewing machines
409 B. M. Oakeshoot, Chelsea—Hot air or medicated vapour bath
410 C. Braker, Oldham—Measuring fluids
411 W. Tongue, Kennington—Straightening fibrous materials
412 P. E. Masey, Regent's Park—Aerial locomotion
413 H. W. Hart, Bayswater—Safety envelopes

7th February, 1868.

414 C. and C. H. Longbottom, Bradford—Spinning
415 J. O'Donnell, Woburn Mews West, and T. Arkill, King's Cross—Raising and lowering venetian blinds
416 S. Read, Edinburgh—Finishing paper
417 J. and J. Cash, Coventry—Looped and textile fabrics
418 A. B. Ibbotson, Sheffield—Steel spring railway fastenings
419 W. Hann, Hetton Colliery—Safety lamps
420 J. Tucker, Islington—Rain water pipes
421 W. Drake, Park Wharf—Cutting wood
422 W. R. Lake, Chancery Lane—Locks.—A com.

8th February, 1868.

423 J. B. Wilson, Haycock—Forging steel
424 G. Harford, Newcastle-upon-Tyne—Scaffolding
425 A. M'Knight, Birmingham—Powder for cleaning and polishing
426 T. Walker, Birmingham—Sewer and drain pipes
427 P. Rothwell, Hampstead Road—Regulating valve
428 A. Philipp, Manchester—Cigar holder
429 J. Nixon, Nuneaton—Braces
430 J. Howard and E. T. Bousfield, Bedford—Steam boilers
431 W. Richardson, Oldham—Combs
432 W. Cowan, Edinburgh—Cases of gas meters
433 J. Key and E. Hoskins, Birmingham—Metallic bedsteads
434 H. Woodward, Hammersmith—Knife cleaner
435 W. Brooke, Manchester, and R. Edmondson—Healds for weaving
436 J. A. Nicholson, London Bridge—Water-closets
437 J. E. Billups, Cardiff—Separating powders
438 W. T. Sugg, Vincent Street—Valves
439 W. B. Marston, Mold—Lamps
440 N. C. Szerelmey, Pimlico—Rendering paper fabrics
441 N. C. Szerelmey, Pimlico—Preserving wood
442 W. R. Lake, Chancery Lane—Split spikes.—A com.
443 W. R. Lake, Chancery Lane—Railway switches.—A com.

10th February, 1868.

444 W. B. Adams, Blackheath—Heating metals
445 W. Burgoyne, Birmingham—Letter and invoice holders
446 W. R. Lake, Chancery Lane—Scouring and cleaning grain.—A com.
447 F. Barnes, Southampton, and D. Hancock, High Wycombe—Communicating motion to signals on railways
448 G. Jessop and B. Senior, Batley—Preparing wool
449 C. E. Brooman, Fleet Street—Pen and ink holders.—A com.
450 A. M. Clark, Chancery Lane—Breech-loading fire-arms
451 H. C. Tucker, Staverton—Clipping sheep
452 H. Schlotter, Kostritz—Raising water
453 J. Tansley, Bedford—Working the rollers of blinds

11th February, 1868.

454 H. A. Dobson, Knightsbridge—Carriage spring
455 T. J. Clanchy, Cheetham—Matches
456 T. Smith, Lambeth—Steam-engine counters
457 C. M. Holland, Tan-y-Bwlch—Permanent way of railways
458 J. W. Melling, Wigan—Cutting coal
459 C. and L. Verhulst, Manchester—Fire-places
460 J. R. Stoney, Leeds—Consumption of smoke
461 W. Pickard, Farsley—Woollen condensing machinery
462 H. T. Humphreys, Westbourne Park Road—Decarburization of molten iron
463 G. Seamer, Milk Street—Silk fancy weavings
464 F. Schafer, Golden Square—Testing eggs
465 A. Brin, Paris—Applying gas from air
466 J. S. Williamson, West Hartlepool—Drying corn
467 W. E. Newton, Chancery Lane—Saving life in cases of shipwreck.—A com.
468 W. T. Wooley, St. Luke's—Locks for purses
469 J. Wenden, Barnsbury, and S. P. B. Fussell, Holloway—Ornamenting glass
470 S. C. Lister, Manningham—Looms
471 H. S. Barron, Barking Road—Double-action reciprocating pumps
472 J. Smith, Cheetham—Boiling animal and vegetable substances
473 A. F. Bayford, St. John's Wood—Watering plants in pots
474 J. Thornton, Polygon, and F. W. Voss, Brunswick Square—Portable weighing apparatus
475 R. Young, Glasgow—Dressing millstones
476 R. C. Ross, Manchester—Cutting paper
477 W. G. C. Hudson, Barnsbury—Revolving stands.—A com.
478 S. B. Tucker, Parliament Street—Cartridge boxes.—A com.
479 W. Wootton, Westminster Bridge Road—Envelopes
480 H. B. Condy, Battersea—Acetic acid
481 J. G. Willans, St. Stephen's Crescent—Iron and steel

12th February, 1868.

482 J. Towle, Cold Harbour—Sewers

13th February, 1868.

483 S. Seville, Lees—Sizeing yarns
484 W. G. H. Taunton, Liverpool—Pumps
485 R. George, Kilburn—Gas stoves
486 F. Grenier, Paris—Kneading apparatus
487 W. E. Deverna, Liverpool—Fastener
488 J. Wood, Keswick—Indicating the position of railway points
489 C. Blyth, Dundee—Measuring and cutting cloth
490 F. Tolhansen, Paris—Brushmaking.—A com.
491 W. Woodfield, Worcester—Papering needles
492 G Roberts, Westminster—Candles
493 W. R. Lake, Chancery Lane—Condensing the volatile portions of ores.—A com.
494 W. R. Lake, Chancery Lane—Whip holder.—A com.

14th February, 1868.

495 D. Elland, York—Passengers travelling in railways signalling driver and guard
496 H. A. Bonneville, Paris—Aniline colours.—A com.
497 H. A. Bonneville, Paris—Carcel lamps.—A com.
498 A. Lemasson, Paris—Dials
499 J. Steele and J. Hastie, Greenock—Treating animal charcoal and sugar
500 J. P. Lack, Basinghall Street—Albums.—A com.
501 W. E. Gedge, Strand—Separating animal from vegetable substances.—A com.
502 G. A. F. Eichbaum, Southampton Buildings—Indicating the amount of money received by omnibus conductors
503 G. V. Wisedill, Islington—Ring for keys

15th February, 1868.

504 J. A. Hogg, Edinburgh—Gas burners
505 J. S. Raworth, Manchester—Connecting and disconnecting revolving cylindrical surfaces
506 R. Martin, Horsham—Deodorizing oils
507 R. H. Rimes, Bradford—Boots and shoes
508 D. Whittaker, Blackburn—Healds
509 W. Easterbrook, Kilburn—Actuating railway signals
510 W. J. Bennett, Westminster, and J. Jobson, Vauxhall Bridge Road—Separating the watery particles of slop and sewage
511 E. Cottam, Battersea—Breech-loading fire-arms
512 B. Farmer, Barrow-in-Furness—Crushing stone
513 A. M. Clark, Chancery Lane—Felted fabrics.—A com.
514 J. Barlow, Oxford Street—Carriages.—A com.
515 L. Mummenboff, St. Mary Axe—Building blocks.—A com.
516 J. Leetch, Birmingham—Transmitting signals

17th February, 1868.

517 J. Clark and T. Vicars, Liverpool—Tobacco box
518 W. H. Tasker, Bradford—Spinning
519 A. H. Brandon, Paris—Breech-loading fire-arms.—A com.
520 J. P. Worrall, Ordsall—Treatment of fabrics
521 W. H. Wilkinson, Chancery Lane—Type composition
522 W. Lincoln, Chancery Lane—Lamp burner
523 J. G. Taylor, Paris—Puzzles and puzzle chains
524 F. Chevass, Paris—Shirt
525 J. Walker, Poole—Ornamental tiles

18th February, 1868.

526 A. M. Dufilhol, Paris—Shoeing horses
527 J. Cronier, Hyde Road—Rotary heels for boots and shoes
528 W. R. Lake, Chancery Lane—Kilns.—A com.
529 L. Wollheim, Trieste—Barometrical purposes
530 R. Butterworth, Patricroft—Looms
531 R. Baguley, Blackburn—Shuttles
532 J. and J. Hinks, Birmingham—Portable stoves
533 A. M. Clark, Chancery Lane—Vegetable extract for culinary purposes.—A com.
534 C. E. Brooman, Fleet Street—Breech-loading fire-arms.—A com.
535 W. Perkins, Fitzroy Square, and G. G. Tandy, Anerly Road—Electric conductors
536 W. E. Newton, Chancery Lane—Artificial teeth.—A com.
537 J. Thompson, Camberwell Road, and J. Thompson, Camberwell Green—Fastening railway rails
538 A. M. Keighly, Beeston—Night and day signals for railways
539 W. Weild, Manchester—Treating sewing threads
540 W. Betts, City Road—Metallic capsules
541 H. Chamberlain, Wakefield—Compressed bricks

19th February, 1868.

542 J. Higginbotbam and L. Moore, Manchester—Polishing rollers
543 T. Beeley, Hyde—Keirs
544 R. Blezard, Liverpool—Cleaning wheat
545 J. Kirkland, Liverpool—Pumps
546 E. Wright, Bradford—Prevention of smoke
547 W. and J. Cooke, Tinsley—Finished irons
548 E. W. Young, Spring Gardens—Bridges
549 J. J. King, Glasgow—Sewing machines
550 W. H. Steele, Clapham—Hand saws
551 W. Edwards, Wolverhampton—Roughening horse-shoes
552 R. P. Fanchenx, Kentish Town—Bobbins
553 W. R. Lake, Chancery Lane—Preserving wood.—A com.
554 G. P. Dodge, Upper Thames Street—India-rubber valves
555 G. P. Dodge, Upper Thames Street—Packing
556 F. H. Renault, Paris—Combined umbrella
557 J. G. Jones, Newport—Exhausting air
558 W. S. Gniness, Cheapside—Sewing machines
559 J. Lord, Oadby—Coupling railway carriages
560 L. B. Joseph, Upper Norwood—Carriage wheels
561 M. Henry, Fleet Street—Nails.—A com.
562 W. Myers, Birmingham—Lockets

20th February, 1868.

563 P. Baner, J. Johnson, and J. Jones, Manchester—Lubricating revolving shafts
564 J. M. Kilner, Chester Castle—Field quarters
565 W. Weldon, Highgate—Chlorine
566 P. N. Goux, Paris—Disinfecting human excreta
567 J. H. Johnson, Lincoln's Inn Fields—Draught in steam-boiler furnaces.—A com.
568 J Hullett, Purbrook—Aëronautical apparatus
569 J. G. Tatters, W. Keeble, and B. Newbury, Plymouth—Cigars
570 T. A. L. Murray, Brompton—Rails for tramways
571 W. E. Newton, Chancery Lane—Mechanical movements
572 G. Davies, Lincoln's Inn—Taps.—A com.
573 W. R. Lake, Chancery Lane—Clipping the wool of sheep
574 W. R. Lake, Chancery Lane—Stoves.—A com.
575 R. Fennelly, London Bridge, and P. Kenny, Waterford—Singeing off the hairs of pigs

21st February, 1868.

576 G. Davies, Lincoln's Inn—Gas.—A com.
577 G. A. Bridgett, Fallowfield—Steam-engine slide valves
578 L. M. Becker, Basinghall Street—Fire-plugs
579 C. Cochrane, Dudley—Blast furnaces
580 W. Thompson and T. Stather, Kingston-upon-Hull—Drying grain
581 H. Walmsley and T. W. Taylor—Registering the number of passengers entering into omnibuses
582 M. A. F. Mennons, Paris—Bristle brushes.—A com.
583 T. Altham, J. Clark, and S. Ridehalgh, Nelson—Sizeing yarns
584 T. and J. R. Bury, Blackburn—Shuttles
585 J. Wheatley, East Moulsey—Chimney pot
586 A. V. Newton, Chancery Lane—Reaping and mowing machines.—A com.
587 W. Wilson, Newcastle-upon-Tyne—Lubricating the sliding valves of steam-engines

22nd February, 1868.

588 A. de Metz, Wolverhampton—Commode pots
589 R. B. Mitchell, Sheffield—Making plane irons
590 J. M'Call, Houndsditch—Preserving meat
591 C. J. Galloway, Manchester—Wrought-iron piles
592 W. R. Lake, Chancery Lane—Supplying type forms in printing presses.—A com.
593 J. Needham, Piccadilly—Fastenings for gloves
594 A. V. Newton, Chancery Lane—Furnaces.—A com.
595 J. J. Aston, Kensington—Propelling ships
596 B. E. R. Newlands, Charlton—Treating spent oxide of iron
597 W. H. Ryland, Birmingham—Fastenings for articles of dress
598 F. Sangster, Lee—Parasols
599 W. R. Lake, Chancery Lane—Electrical signal.—A com.
600 S. Firth, Leeds—Cutting coal
601 E. J. Nicoll, Oxford Street, and T. M. Ablett, High Holborn—Waist springs for boots and shoes
602 W. Krutzsch, London—Washing clothes.—A com.
603 R. Heathfield, Birmingham—Cut nails

24th February, 1868.

604 H. Chamberlain and J. Craven, Wakefield, and H. Wedekind, Mincing Lane—Burning bricks.—A com.
605 J. W. Watts, St. Luke's—Preparing vegetable fibre
606 A. Spenger, Gresham Street—Umbrellas
607 P. H. Hancock, Pimlico, and J. P. French, Wandsworth Road—Printing machines
608 J. S. Gisborne, Liverpool—Preventing collisions at sea
609 J. Macintosh, Regent's Park, and W. Boggett, Chelsea—Elastic goods
610 J. Fordred, Blackheath, F. Lambe and A. C. Sterry, Rotherhithe New Road—Treatment of paraffin
611 W. E. Newton, Chancery Lane—Illuminating gas.—A com.
612 R. Nicholas, Aldermanbury—Combined fabric
613 G. S. Dracopulo, Cardiff—Raising water
614 W. R Lake, Chancery Lane—Steam boilers.—A com.
615 R. and J. J. Bodmer, Monmouth, and L. R. Bodmer, Notting Hill—Artificial stone
616 W. R. Lake, Chancery Lane—Artificial breasts.—A com.

25th February, 1868.

617 H. Defries, Houndsditch—Glass lamp
618 J. Vevers, Leeds—Spinning.—A com.
619 F. Le Roy, Commercial Road—Non-conducting composition
620 J. Elce, Manchester—Lubricating the spindles of machines for spinning
621 E. T. Hughes, Chancery Lane—Hoop skirts.—A com.
622 E. Hutchinson, Darlington—Multiple drilling machines
623 E. Hutchinson, Darlington—Planing machines
624 G. W. R. Pigott, Halifax—Coated wire
625 J. and W. Dohbs, Manchester—Ventilation of hats
626 J. J. and E. Harrison, Manchester—Healds of looms
627 J. C. Davies and E. Zahn, Kingsland Road—Muffs
628 F. Remy, Paris—Steel seat
629 J. M'Leod, Renton—Washing yarns
630 J. T. Kent, Sheffield—Mattresses
631 O. Olliver, Paris—Exhibiting advertisements
632 J. L. Jaquet, Pimlico—Heels for boots and shoes.—A com.
633 C. Pieper, Finsbury Square—Preparing wood.—A com.
634 G. T. Bousfield, Brixton—Raising water.—A com.
635 C. Pieper, Finsbury Square—Reaping machines
636 R. Kerr, Paisley—Heating conservatories
637 A. M. Birchall, Preston—Twist tobacco
638 R. Ramsey, Upsal Pit, and J. Cooke, Darlington—Signal indicators

26th February, 1868.

639 G. C. Mackrow, Blackwall—Batteries for ships of war
640 T. Lythgoe and H. Thornton, Manchester—Walls
641 L. Pocock, Gordon Square—Bookbinding
642 T. Hill, Merrylee—Bearings for axles.—A com.
643 R. Laidlaw and J Thomson, Glasgow—Exhausting gas for blowing air
644 E. R. Walker, Fenton—Transmitting motive power
645 W. E. Gedge, Strand—Machine intended to divide, break, or crush.—A com.
646 J. Perrett, Dulwich—Bottles for feeding infants
647 A. V. Newton, Chancery Lane—Electro-magnetic apparatus.—A com.
648 F. Lambe and A. C. Sterry, Rotherhithe New Road, and J. Fordred, Blackheath—Purifying hydrocarbon oils
649 F. Mittonette, Deepfields—Furnace doors
650 W. E. Newton, Chancery Lane—Washing machine.—A com.
651 W. Dowell, Rhyl, and J. Dowell, Penmaenmaur—Locks
652 R. and J. W. Gaunt, Farsley—Spinning

27th February, 1868.

653 F. Wirth, Frankfort-on-Maine—Pedals.—A com.
654 F. Dumas, Paris—Impervious bathing dresses
655 J. R. Cooper, Birmingham—Breech-loading fire-arms
656 R. A. Hope, Island of Jersey—Sweetening
657 T. Blocksage, Dukinfield—Boilers
658 C. C. and W. T. Walker, Donnington—Centre valves for gas purifiers
659 R. E. Green, Church—Cotton yarns
660 L. Boyce, Manchester—Raising and lowering venetian blinds
661 J. B. Whiteley, Lockwood—Finishing woven fabrics
662 W. Weldon, Highgate—Chlorine residues
663 J. Adams and J. Barrett, St. Helier—Stopper for bottles
664 W. E. Newton, Chancery Lane—Building of vessels.—A com.
665 W. E. Newton, Chancery Lane—Pens and penholders.—A com.
666 J. Petrie, Rochdale—Washing wool
667 J. H. Bass, Featherstone Street—Double cans
668 W. M. Bullivant, Fenchurch Street—Preventing the fouling of iron
669 G. Eldridge and W. E. Loc, Dalston—Closing bottles
670 G. Hart, Wakefield—Preventing smoke in furnaces

28th February, 1868.

671 J. Christie, Newcastle-upon-Tyne—Lithographic printing machine
672 R. Mills, Bury—Washing
673 J. Livesey, Westminster—Coupling carriage wheels
674 J. G. Stidder, Long Acre—Water-closets
675 A. S. Stocker, Horsleydown—Caps or covers
676 R. Howard, Southampton—Taps and cocks
677 C. E. Brooman, Fleet Street—Moulds.—A com.
678 J. Leacock, Castlewellan—Paving streets
679 J. Robinson, Greenfield—Cleaning
680 J. Dunkerley, Denton—Hats
681 G. Thomas, Oldham—Sewing machines
682 T. Warren, Glasgow—Glass furnaces
683 J. F. Low, Monifieth—Preparing jute
684 T. Trotman, Camden Town—Folding carriages

685 W. E. Newton, Chancery Lane—Finishing felted goods.—A com.
686 C. Sanderson, Worksop—Iron and steel
687 T. S. Whilock and H. Harford, Birmingham—Fastenings for window sashes
688 J. Gjers, Middlesborough—Cast steel

29th February, 1868.

689 C. Cochrane, Dudley—Hot-blast water tuyeres
690 E. Baker, Mortimer Street—Screw bolts
691 H. B. Wilder, Sulham—Magnetic electric télegraphic apparatus for signs
692 J. Collins, Dublin—Filling cartridge cases
693 L. C. Detouche, Paris—Omnibus indicator
694 J. W. M'Carter, Londonderry—Heating the feed water of steam-engine boilers
695 G. Lindsley, Swindon—Motive power for propelling carriages
696 W. Smith, J. Giddings, and J. Rank, Hull—Fire-escape
697 A. H. Hill, Inner Temple—Luggage labels
698 R. Zwez, Hampstead Road—Can
699 J. L. Norton, Ludgate Hill—Sinking wells
700 W. Barford, Peterboro', and T. Perkins, Hitchin—Stacking straw
701 B. Solomons, Piccadilly—Telescope
702 L. B. Schmolle, Aldermaubury—Skeleton skirts

2nd March, 1868.

703 W. J. Armstrong and C. Browne, Brixton—Anchors
704 H. Wilson, Stockton-upon-Tees—Meters
705 L. Roman, Paris—Motive power from rivers
706 W. Rollo, Dundee—Water-closets
707 J. Rawsthorn, Preston—Dressing millstones
708 W. E. Newton, Chancery Lane—Burning hydrocarbons
709 F. Neiher, Vienna—Fastenings for glove boxes
710 T. Horsley, York—Breech-loading fire-arms
711 S. Sharroch, Liverpool—Piles
712 A. Smith, Litchurch—Railway waggon axle boxes

3rd March, 1868.

713 A. A. Usher, Canonbury—Respirators
714 W. E. Gedge, Strand—A mineral paperhanging
715 C. Cochrane, Dudley—Valves or dampers for pipes
716 H P. Reynoldson, Bunhill Row—Making portfolios with metallic hacks
717 F. Moss, Eccles—Registering passengers travelling by public vehicles
718 J. Barker, Todmorden—Consuming smoke
719 T. Bissett, Marlee—Reaping and mowing machines
720 W. B. Thompson and W. Gall, Dundee—Winding yarns or threads
721 J. A. Haswell, Gateshead, and G. Brown, York—Signal apparatus
722 J. Manly, Birmingham—Nails which are used for ornamental purposes
723 W. Spence, Chancery Lane—Making nails.—A com.
724 H. Zox, Blackfriars—Hats and caps
725 W. Whittle, Harborne—Steam-engines
726 J. Dewar, Kirkcaldy—Preserving blood for use as food
727 G. Anderson, Strand—Moulding
728 E. Burton, Clapton, and J. Lawrence, Uckfield—Screening and sifting coals
729 H. Kennedy, Chancery Lane—Cutting files
730 S. A. Bell, Bow Lane, and G. H. Higgins, Bow—Match boxes
731 T. Johnson, Runcorn—Treating ores
732 J. W. and C. R. Harriaon, Hampstead Road—Parallel rulers
733 B. W. A. Sleigh, Portland Place—Hydrostatic engines
734 J. A. Lee, Lydney—Cutting wood
735 J. W. Nasarow, Finsbury Square—Iron and steel.—A com.

4th March, 1868.

736 F. Cadby, Birmingham—Cruet and egg frames
737 S. Jeffrica, Stroud—Securing ropes
738 T. Smith, Leeds, T. Wood, Birstwirth, and T. Don, Red Hill—Cleaning grain
739 A. Cole, Erith, and J. Carter, Bexley Heath—Lamps
740 E. Clifton, Bradford—Door handles
741 J. Lwthwaite, Woburn Place—Treating parkesine
742 H. E. Smith, Hereford—Winding gear of engines
743 A. M. Clark, Chancery Lane—Paving roads.—A com.
744 W. K. Stuart, Glasgow—Utilizing sewage
745 J. G. Kincaid, Greenock—Twin screw-propelling apparatus
746 W. and T. Mitchell, Stacksteads—Felt carpeting
747 G. Davies, Lincoln's Inn—Gas for lighting.—A com.
748 C. Scholefield, Beverley—Suspending window sashes
749 J. Askew, Hampstead Road—Window blind cords
750 J. Brigham and R. Bickerton, Berwick-upon-Tweed—Reaping and mowing machines
751 J. Cole and A. Maxfield, Birmingham—Sewing machines
752 C. R. Rockley, St. Paul's—Pipes for smoking tobacco
753 C. Schinz, Strasbourg—Partial elimination
754 A. V. Newton, Chancery Lane—Measuring spirituous liquors.—A com.

5th March, 1868.

755 F. T. Baker, Fleet Street—Cartridge cases
756 J. J. F. Stevens, Southwark—Railway signal
757 J. Hammersley, Clerkenwell—Marine chronometer boxes
758 H. A. Dufrené, Finsbury—Covers for jars
759 W. Hunt, Castleford—Treating copper and iron
760 W. R. Lake, Chancery Lane—Preparing soles
761 W. E. Gedge, Strand—Steam-engines.—A com.
762 J. Westray and J. Forster, Barrow-in-Furnesa—Drilling and boring
763 J. Hartshorn, Nottingham—Lace in twist lace machines
764 J. L. Clark, Beechmont—Differential galvanometers
765 C. H. Gould, Birmingham—Combined rivets
766 J. B. Fell, Sparke Bridge—Locomotive engines
767 H. Drake, Pall Mall—Essences suitable for soups
768 H. Conybeare, Westminster—Rails
769 A. V. Newton, Chancery Lane—Cultivating land.—A com.
770 A. M. Clark, Chancery Lane—Steam pumps.—A com.
771 J. Dickson, Belfast—Lubricators

6th March, 1868.

772 D. Price, Dudbridge, and C. Rowe, Brimscombe—Comb for cleaning animals
773 J. L. Pulvermacher, Regent Street—Producing the power of electric currents
774 J. Brinsmead, Wigmore Street—Pianofortes
775 J. M. Stanley, Rhyl—Furnaces
776 T. Whittaker, Manchester—Paper
777 J. Eastwood, Blackburn—Sizing yarn
778 G. Hauxwell, Durham, and J. Ryder, Sunderland—Preparing hard foreign wheat
779 W. Langwell and H. Spring, Attercliffe—Bottles
780 J. Watson, Sunderland—Blast furnaces
781 T. Atkins, Fleet Street—Gloves
782 T. Atkins, Fleet Street—Extinguishing fire
783 T. Atkins, Fleet Street—Feeding bottles
784 J. Parker, Camberwell—Motive-power engines
785 J. Houston, Glasgow—Composite candles
786 J. G. Tongue, Chancery Lane—Steam boilers

7th March, 1868.

787 H. Hargreaves, Burnley—Looms
788 J. Campbell, Lotbbury—Floating docks
789 S. Brown, Blackfriars Road—Ornamenting bottles
790 R. Leake and R. Platts, Manchester—Engraving rollers for printing
791 H. Symons, Kentish Town—Fire-guards
792 H. Simmonds, Mark Lane—Hulling cotton
793 C. E. Brooman, Fleet Street—Combing machinery.—A com.
794 A. C. Kirk, Glasgow—Treating cast iron
795 W. Berry, Bradford—Foot steps for upright spindles
796 R. Tooth, Fenchurch Street—Evaporation of liquids
797 R. M. Chevalier, Notting Hill—Venetian blinds
798 J. Thompson, Camberwell Road, and J. Thompson, Camberwell Green—Door knobs
799 W. H. Warner, of Ross, and R. C. Murray, Jermyn Street—Stereoscopes
800 W. W. Greener, Birmingham—Central fire breech-loading guns and pistols
801 F. J. Bayne, Islington—Kitchen ranges
802 E. Casper, Cannon Street—Raising and forcing liquids.—A com.
803 P. Koch, New Haven—Making metallic nuts

9th March, 1868.

804 H. M. Lee, Manchester—Cases for containing visiting or address cards
805 J. Jeavons, Sheffield—Tyres for railway wheels
806 W. Hartley, Heywood—Preparing yarn
807 H. B. Barlow, Manchester—Carding.—A com.
808 C. D. Abel, Chancery Lane—Screw bolts.—A com.
809 L. Blumfeld, Cheapside—Cigar tubes and pipes
810 A. F. Baird, Pimlico—Earth closets
811 W. Pidding, Brunswick Square—Purses formed in gloves
812 H. Willis, Camden Road—Organs
813 P. W. Barlow, Blackheath—Tunnels
814 E. Morewood, Cheam—Coating metal plates
815 W. H. Halsey, Hoboken—Making articles from hard rubber
816 A. M. Clark, Chancery Lane—Freezing liquids.—A com.
817 P. F. Halbard, Burton-on-Trent—Stench traps
818 W. R. Lake, Chancery Lane—Fibrous materials.—A com.

10th March, 1868.

819 J. Slater, Lansdowne Road—Heating the feed water for boilers
820 W. B. Kinsey, Cannon Street—Carburetting the illuminating properties of coal gas
821 C. D. Abel, Chancery Lane—Brown colouring matters.—A com.
822 S. Deshorough, Staining Lane—Cleaning and polishing knives
823 J. Jones, Consett Iron Works—Finishing and punching bars of iron
824 R. Meldrum, Pittormie—Raising water
825 J. G. Douglas, Cork—Valve motions for oscillating cylinder engines
826 J. Vero, Dewsbury—Hats
827 A. Bourdon, Paris—Looms
828 A. V. Newton, Chancery Lane—Lubricating machinery.—A com.
829 J. Wallis, Greenwich—Dressing millstones
830 C. Attwood, Wolsingham—Steel and iron
831 H. E. Smith, Hereford—Steam-engines
832 R. Cocker, Charing Cross—Treatment of flax, hemp, and jute.—A com.

11th March, 1868.

833 S. Brooks, West Gorton—Spinning cotton
834 E. and J. Broadbent, Manchester—Paper bags
835 F. Winser, Manchester, and J. Swindells, Kegworth—Utilization of the waste products arising from esparto grass
836 F. Winser, Manchester, and J. Swindells, Kegworth—Sulphate of magnesia
837 B. Browne, King William Street—Rails
838 T. Walker, Chelsea—Electric telegraph cables
839 S. Naylor, Ravensfleet—Raising water
840 M. T. Shaw and T H. Head, Cannon Street—Rolling iron and steel
841 P. Lennox, Lynn—Beaming hides or skins
842 W. Hawthorn, Newcastle-upon-Tyne—Steam generators

12th March, 1868.

843 F. A. Paget, Adelphi—Ship's compasses
844 J. Bourne, Regent's Park Road—Auxiliary propulsion
845 F. Ryland, West Bromwich—Pulleys for suspending window frames
846 W. Thompson, Barking Road—Iron castings
847 H. Fletcher, Liverpool—Motive power
848 W. A. Lyttle, London—Boilers
849 W. E. and F. A. Bush, Commercial Road, E.—Trap for catching animals
850 T. Barnes, How Gill—Preparing rovings from waste
851 A. P. Stevens, Brooklyn—Vases
852 J. Hodgeson, Latchford—Railway signals
853 W. E. Newton, Chancery Lane—Ballasting vessels.—A com.
854 A. and E. Geary, Bristol—Cinder sifters
855 B. Britten, Red Hill—Manure

13th March, 1868.

856 E. K. Dutton and J. and H. Holme, Manchester—Sewing machines
857 J. H. Maw, Broxley—Lamps
858 S. Bates and W. Redgate, Nottingham—Lace
859 A. Taylor, Wolverhampton—Brakes
860 G. F. Lyndon, Birmingham—Rotating shafts
861 M. Rowand, Lewisham—Fermented liquors
862 W. M'Naught, Rochdale—Steam-engines
863 C. S. Möller, Philpot Lane—Portable side weapon.—A com.
864 H. Kershaw, Laister Dyke—Spinning worsted
865 C. R. Broadbent, Chancery Lane—Hats
866 S H. Salom, Regent Street, and H. Field, Vine Street—Clipping the hair of horses
867 J. Betteley, Liverpool—Sheet metal

14th March, 1868.

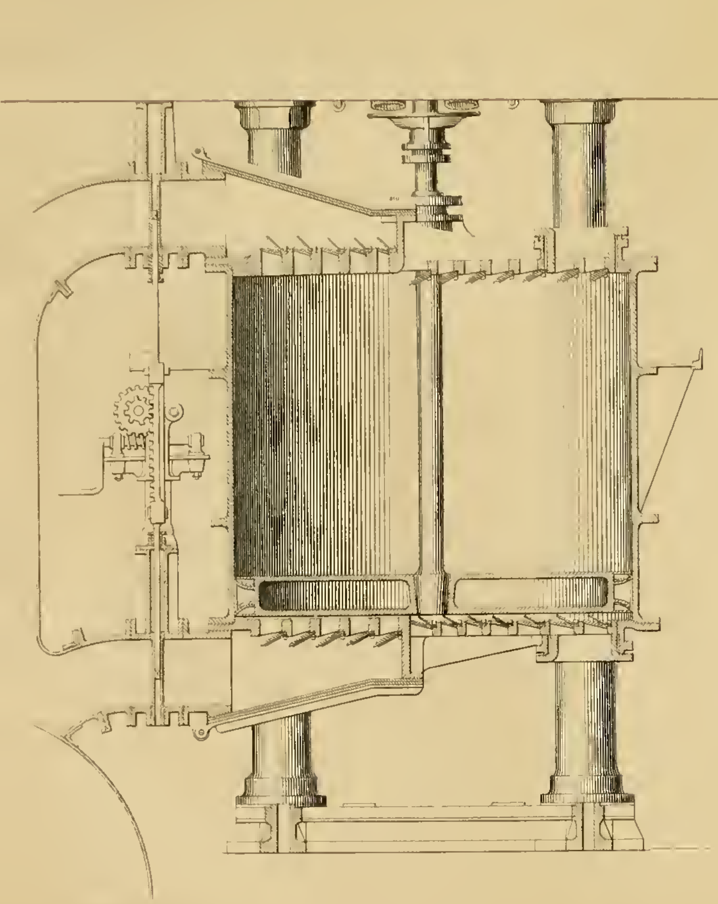
868 W. G. Beattie, Surbiton—Steam pistons
869 S. Holness, Kingsland—Speaking tubes
870 N. Jacobsohn, Berlin—Self-acting letter box
871 W. Bellhouse and R. Ashworth, Manchester—Carding engines
872 J. B. Handyside, Glasgow—Supplying springs
873 J. P. Knight, New Cross—Indicator lamps
874 J. Petrie, Rochdale—Washing wool
875 F. Mulliner, Northampton—Splinter bars of carriages
876 J. Clay, Yardley—Harness
877 J. Carter, Birmingham—Nails and spikes
878 W. A. Lyttle, General Post Office—Securing boxes
879 P. F. Gubault, Angers—Finishing boots and shoes

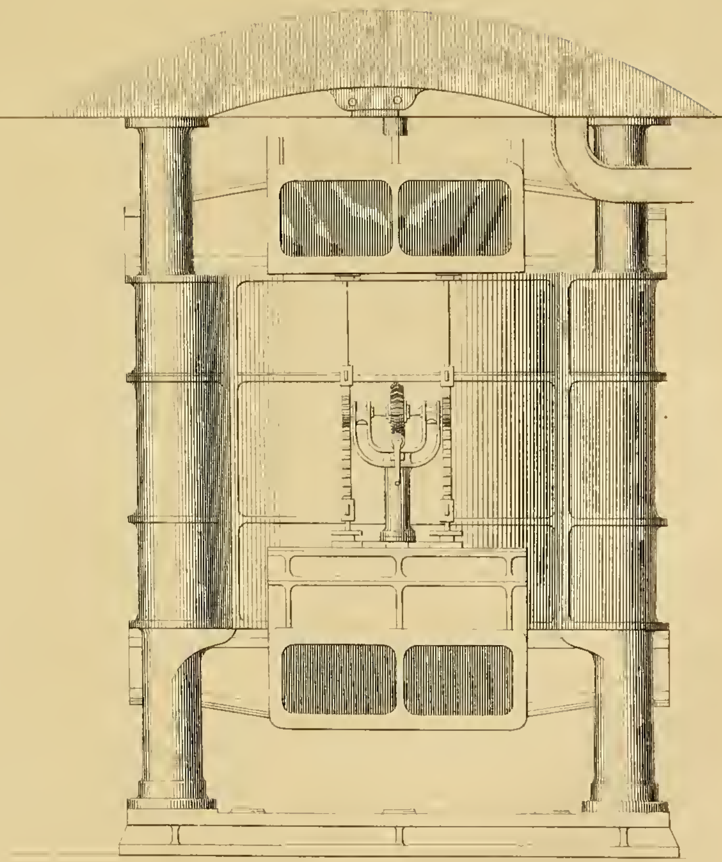
16th March, 1868.

880 J. Norman, Glasgow—Dressing millstones
881 E. V. De Forville, Nantes—Sifting flour
882 A. Bauman, Heilbronn—Rotary engines
883 T. S. L. Beech, Charlton—Engines
884 H. F. Griffiths and A. Beard, Wolverhampton—Puddling iron and steel
885 W. Arthur, Surrey, and W. Arthur, Regent's Park—Cure of hernia
886 H. A. Bonneville, Paris—Jacquard loom.—A com.
887 H. A. Bonneville, Paris—Permanent way of railroads.—A com.
888 H. A. Bonneville, Paris—Cartridges
889 F. H. and C. A. Elliot, Strand—Telescopes.—A com.
890 D. Greig, Leeds—Traction engines
891 W. E. Newton, Chancery Lane—Illuminating gas.—A com.
892 W. E. Newton, Chancery Lane—Telegraphic apparatus.—A com.
893 J. Murray, Newcastle-upon-Tyne, and R. Warden, Gatesbead—Lamps
894 J. H. Johnson, Lincoln's Inn Fields—Wheels.—A com.
895 P. J. Livsey, Manchester—Combing cotton
896 J. S. Gee, Gloucester—Ornamenting slate

BLAST ENGINES.

CREUSOT IRON WORKS.

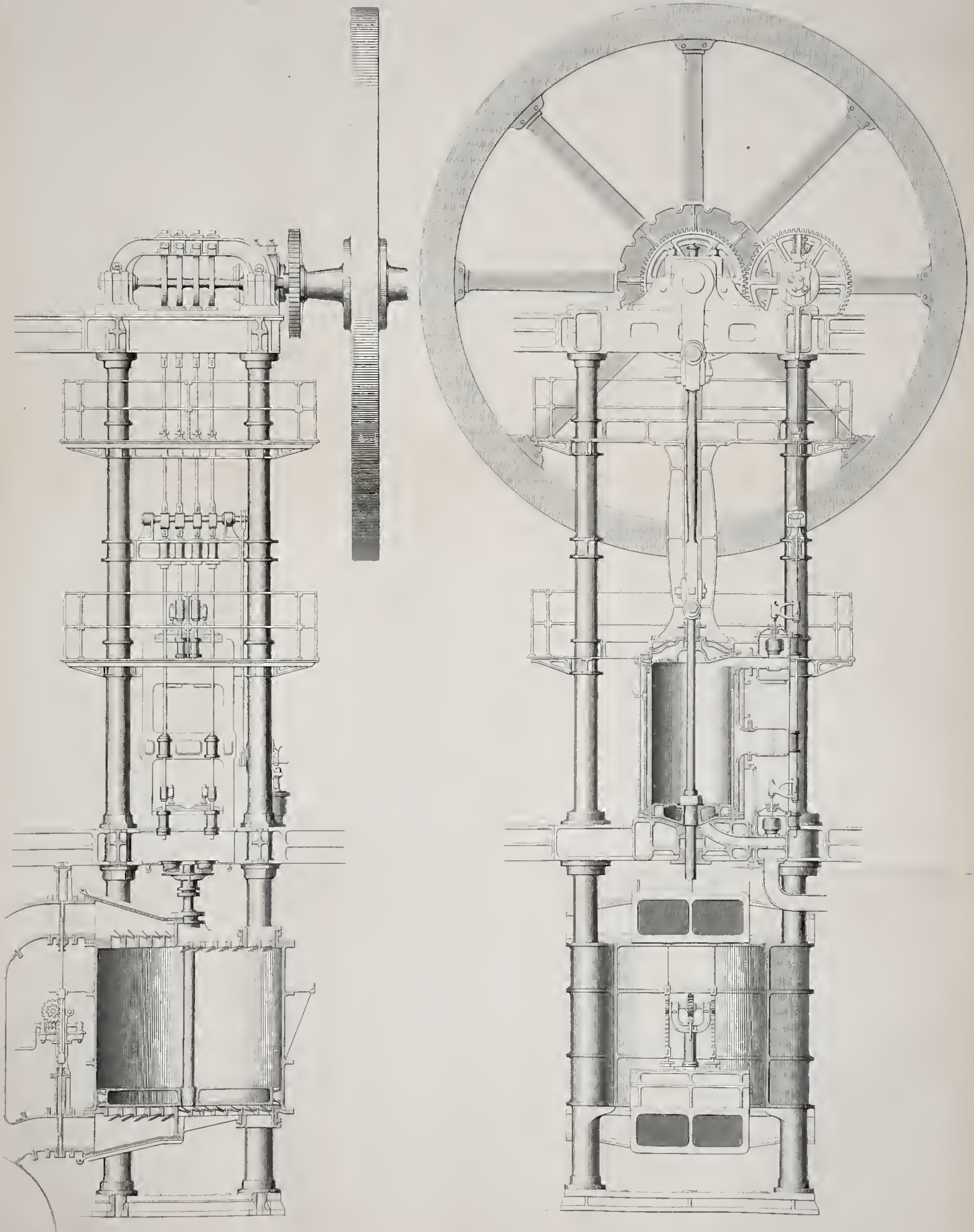




Offices 47 Lincolns Inn Fields London
and 166 Buchanan St Glasgow

BLAST ENGINES,

CREUSOT IRON WORKS



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MR. FAIRLIE'S SYSTEMS OF LOCOMOTIVE ENGINES FOR STEEP INCLINES OR LIGHT TRAFFIC.

In our last article we described and offered some critical remarks upon Mr. Fairlie's system of engine construction, which comprehends railways, no matter how circumstanced; though the merits of his designs unquestionably come out most saliently on those lines which either by nature, *i.e.*, by the configuration of the country traversed, by the unskilfulness of the laying out, or by the unfavourable amount or character of traffic, are those which the existing locomotive system oppresses to the utmost.

We have been furnished by the inventor himself with the following comparative table, which we present to our readers without either our own endorsement or contradiction. Let it be taken for what its validity will bear, and without regard to any preconceived notions, however generally well founded, as to the over-sanguine views which innovators are apt to take as to the value of their own improvements. No true king of men was ever free of this grain of enthusiasm; were he so, he would be little likely to lead. It is the sanguine man who says to the multitude, "Come on," not the cautious one, who stands safe within the crowd, and says in cool and politest tones, "Go on," who is the real "leader of men." Here is what Mr. Fairlie says may, in moneys numbered, be done with railways if those who manage them will drop their well-thumbed hornbooks and take to his new primer:—

COMPARISON OF THE FAIRLIE SYSTEM TO THE ORDINARY SYSTEM.

	Fairlie's System.	Ordinary System.	Percentage of Difference.
Cost of railway, single line, per mile,	£3000 made on the surface with light rails, and no heavy works, also utilizing the common roads.	£6000 made on the ordinary plan of heavy works, also utilizing the common roads.	100 per cent. in favour of Fairlie's system.
Proportion of *dead* weight to *paying load*,	55 per cent.	87½ per cent.	32½ per cent., do.
Proportion of tons of *paying* load carried to *dead weight*,	1 to 1⅛	1 to 8	600 per cent., do.
Average working expenses to gross earnings, taking the present cost of working the ordinary system as a guide,	25 per cent.	50 per cent.	50 per cent., do.
Percentage earnings available to pay dividends to shareholders,	75 per cent.	50 per cent.	50 per cent., do.
Assumed amounts on which dividend has to be paid; say, one mile of line,	£3000	£6000	100 per cent., do.
Taking the profits to be 5 per cent. on the ordinary system—say, on £6000., viz., £300; the Fairlie system being worked at half the cost will produce 5 per cent. more than this sum; consequently there will be £450 available for division instead of £300,	£450	£300	50 per cent., do.
Proportionate rate of dividend, therefore, will be 5 per cent. on £6000, ordinary system; 15 per cent. on £3000, Fairlie's system,	15 per cent.	5 per cent.	200 per cent., do.

Probably amongst the items in the table which admit of debate, that which will be most earnestly contested by locomotive and traffic managers of the existing state of things, will be the amount of profitless dead-weight carried upon the average of our lines. We shall leave that to those who ought to have the facts under their hands, but with this remark, that we do not believe exact or trustworthy data exist as to the actual *average* dead-weight in proportion to paying traffic per annum carried over any railway in Great Britain. If the managers and directors themselves do not *know*, how are views such as the above, even were they ever so erroneous, capable of refutation? and why do not directors or shareholders insist on having the actual facts ascertained and tabulated?

However, we now pass from Mr. Fairlie's system of locomotive engine, properly so called, to a later design of his for a combination of engine, tender, and passenger carriage combined in one, and in such a way, that while the gross load is pretty evenly distributed over the whole of the wheels, the whole of these are drivers—and so the entire load carried, *i.e.*, the useful load, comes to be available for producing adhesion along with, and in aid of, that of the dead-weight, or that necessary for the production and maintenance of power and for the conveyance of the passengers and goods.

This system, as will be gathered from fig. 1, being a longitudinal section of the carriage, were we in jocose mood, might be called *Fairlie's Coach-omotive.* The design, in fact, is for a peculiar engine and tender, skilfully combined; and upon the back of these, or of a great portion of them, is mounted a passenger carriage, capable of conveying some seventy-five passengers with their baggage. The weight of the entire system, passengers included, the inventor states, would be within that of the present heavy locomotive alone, as at present running; and this says nothing of the long string of carriages and vans, &c., behind it.

It was urged by the late Robert Stephenson, and justly, as the capital argument against the atmospheric railway system as a means of general railway haulage, that the expenditure of power was with the atmospheric the same, or almost precisely the same, no matter how the load varied, whilst with the locomotive the expenditure for power was proportionate to the load. This is true; but of what real value in practice is the barren dynamic fact, while it remains *untrue*, that the expenditure for power with the existing locomotive system is proportionate to the *useful* load drawn. In reality, the difference between the value of the locomotive and the atmospheric, *quo ad* the pockets of the shareholder and of those who have to pay for travelling, is reduced to a point that probably often falls to nothing, in consequence of the fluctuations in passenger traffic at different times and along different lengths of long routes, or in reverse traffic, being such that the useful load often becomes almost or altogether zero. How many trains there are even on the London and North-Western Railway, for example, which, drawn by a huge 35 or 40 ton engine and tender, and with six to ten carriages of 7 to 10 tons each, and probably two brake and luggage vans, yet come into or leave Euston Square Station with far less than seventy-five passengers in all! That is to say, a train with engine and tender, weighing from 100 to perhaps 150 tons, has gone over probably 50 miles of road, and has carried on the average of the whole distance travelled about 5 tons of passengers, and perhaps another 5 tons of their luggage—*one-tenth* or *one-fifteenth* of the dead load dragged; and this is not an extreme case. We have travelled from London to Holyhead before now by the Irish mail train, with under half a dozen passengers in all, and in such a train as the above.

Now, Mr. Fairlie's view, whatever may be questioned as to its details, cannot in principle be gainsayed; it is simply this, to make a reality, and no longer a sham, of that which Stephenson said constituted the value and the beauty of the locomotive.

To do this Fairlie says, Make your horse-power *ex necessitate rei*, or by construction, as nearly as possible precisely equivalent to your useful load of passengers, everywhere and upon all occasions. Just as the omnibus proprietor yokes on his two "fresh and able machiners," and if his load is likely to be larger for a time or permanently, adds a third horse, or developes into a "four in hand;" so he says, Divide your whole carrying and hauling system into separate machines, each with accommodation for a moderate-sized load, and with power ample to drag that at such a speed as you require; and with this flexible system of united carriages and engines you will waste less power, have less dead weight inevitably to drag, and making your total load available for adhesion, can have a cheaper line, because you can thus have curves almost as short as you please, and gradients as steep as those of Mont Cenis; and with less wear and tear both of permanent way and of rolling stock as a final result, your shareholders' dividends may be largely increased, if not actually doubled, as compared with what they are now.

We believe he is right in the main, though we think we can almost hear the growl of dissatisfaction and disapproval with which such heterodox proposals, or the bare notion of such unorthodox *Coach-omotives* making their first appearance "on trial" on any British line, is likely to be received by the whole fraternity of superintendents and traffic managers, to say nothing of the safe "old stock" of railway engineers. That there would be for a time, perhaps, some little reluctance on the part of the public to travel in such intimate acquaintance with, and superiority of position to, a hissing high-pressure boiler,

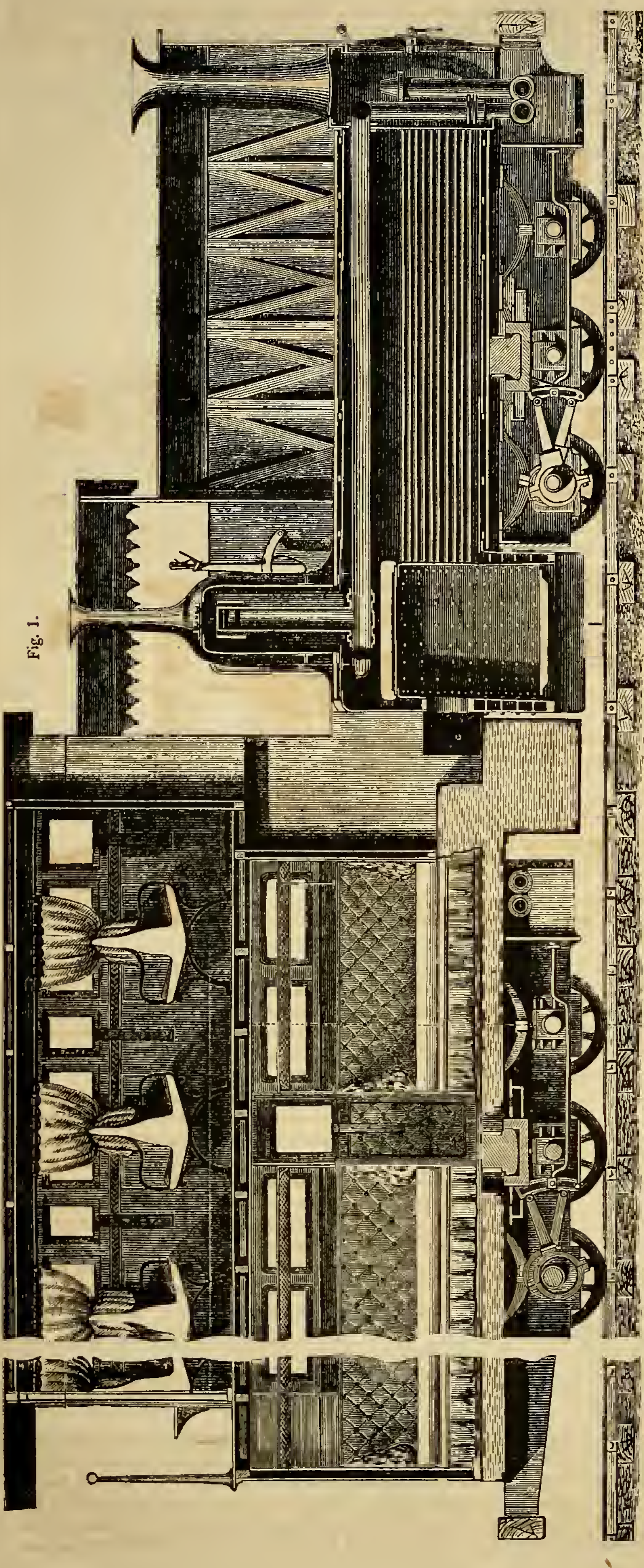


Fig. 1.

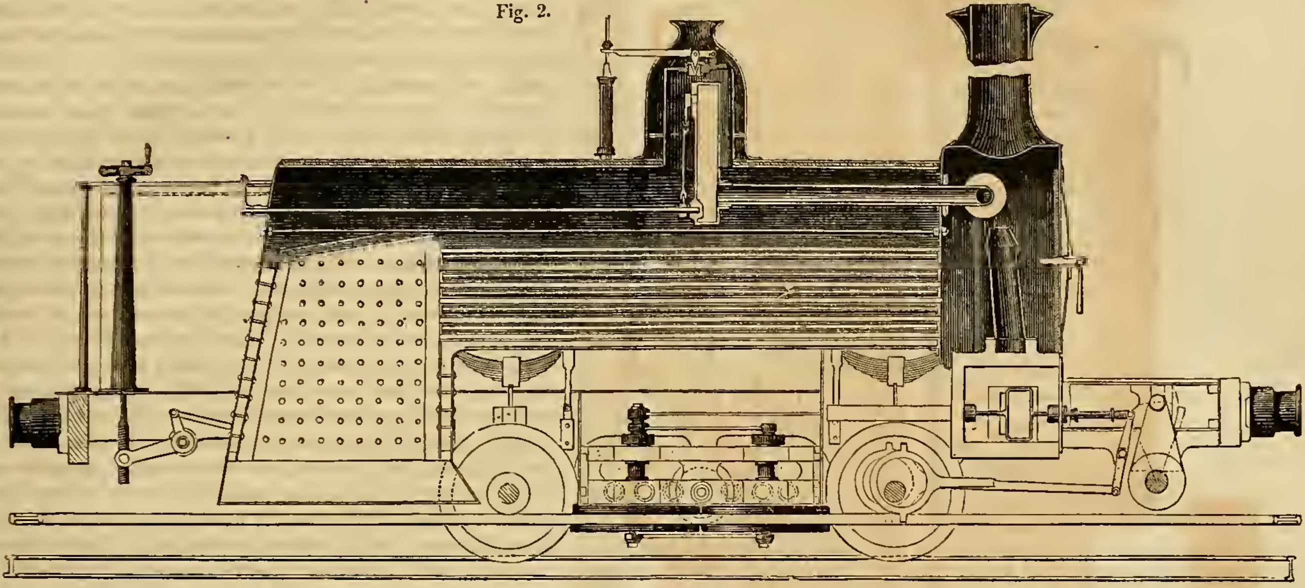
is probably true. That objection, however, would soon wear out. The reality of danger would not be one whit more than at present with the locomotive, in innumerable examples. Thus, upon the old Dublin and Kingston Railway the engines are all tank engines, and the passenger second-class carriages, which carry the vast proportion of the whole of its enormous traffic, run frequently, if not constantly, in direct contact with the engine, not even one of the light luggage vans (alone in use on that line) between. We have often travelled on that line looking out of the end windows of the carriages at the engine driver upon his footplate within 5 feet of us, and with the fire-box end of the engine not 8 feet from our seat. Yet this line has been now and in this way carrying one of the heaviest passenger traffics in Great Britain for nearly twenty years, and has never blown up or scalded a single passenger. Are Mr. Fairlie's *Coach-omotives* likely to expose the passenger to a bit more danger? Again, it may be said if you don't blow up your passengers you will do worse, for you will roast or stew them to a lingering death, if they ever can be entrapped into your carriage with its seats just over the boiler. How much reality there would prove to be in this, would, in our judgment, just depend upon the amount of ingenuity and skill displayed in the design and arrangement of the details of the carriage. Whilever it is possible to keep the inside of a carriage comfortably warm in Russia, as it whizzes through the air at 40° below zero, merely to stand unprotected in which for an hour or two is death, we shall be slow to believe that it is not within the reach of *very* moderate mechanical ability to enable even the hottest and most vapourous and nervous dowager to sit upon a seat not 12 inches above a locomotive boiler, and yet without her being conscious of anything terrible or tartarean incommoding her from below. One is not always quite free from subsedial dangers in railway carriages just at present, as certain burst tyres that have suddenly become inside passengers through the floor have proved—but here ignorance is bliss.

Much more of this same sort might be urged against these new engines, much of which would admit of no complete *ductor dubitantium* answer. The true answer is, let them be tried—not once, cursorily, and with the foregone conclusions that they will be condemned, " and serve 'em right," but with sufficient impartiality, time, skill, and perseverance; and, as in everything else that belongs to man or his doings, half the imagined difficulties will vanish in the accomplishment.

Mr. Fairlie proposes these engine-carriages (they really want a significant name, and we would be sorry to convert ours into a nickname) as a means for surmounting steep gradients, as well as for economy in conducting ordinary traffic of ordinary lines. He states himself prepared to produce engines of this sort competent to work the Fell Railway over Mont Cenis. The engines designed for that line, of the design of which we present our readers some notion in figs. 2, 3, and 4, have certainly not so far proved a success, though of the precise nature of the hitch which has caused their failure very discordant accounts are given. The more trustworthy of these attribute the breaking down of (as we are informed) every engine which was tried upon the line at the beginning of this year, not, as publicly stated, to badness of material used in their construction by the French locomotive builders to whom they were entrusted, as one of the conditions of the French government concession of the line, but to the fact that no provision was made by design for the variable rotation required upon the part of the four horizontal wheels which grip the mid rail (by spring pressure, in lieu of insistent adhesion, which constitutes the main feature of this line and of its engines) to enable these to pass round the curves of short radius, allowing for the difference in curved length, between the inner and the outer sides of the mid rail at such parts. These gripping wheels, by their very nature, *refused to slip* so as to accommodate the difference of travel, and so the accommodation was effected by the breakage of some of the parts. If this be so, it indicates a strange oversight, though it tells for nothing as against the mid-rail gripping system itself.

How easy would it have been, for example, to have made all these gripping wheels with pretty deep conical treads or faces, and put each pair upon such a frame as would have enabled the inner or either pairs or both to have been raised or lowered, so that the smaller part of the cone should have been in contact with the mid rail at the same time that the larger part of the cone of the outer wheels were in contact with the outside.

Fig. 2.



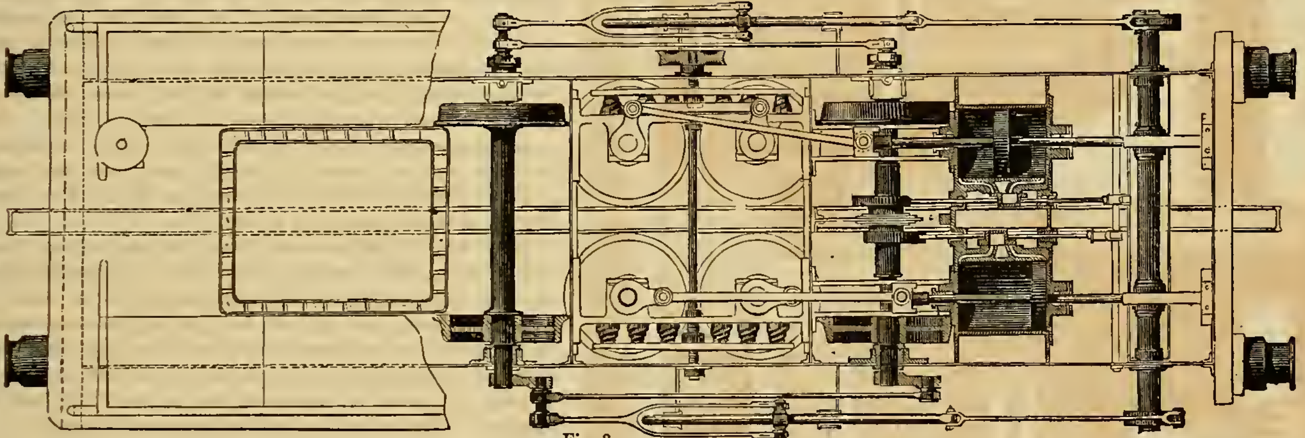
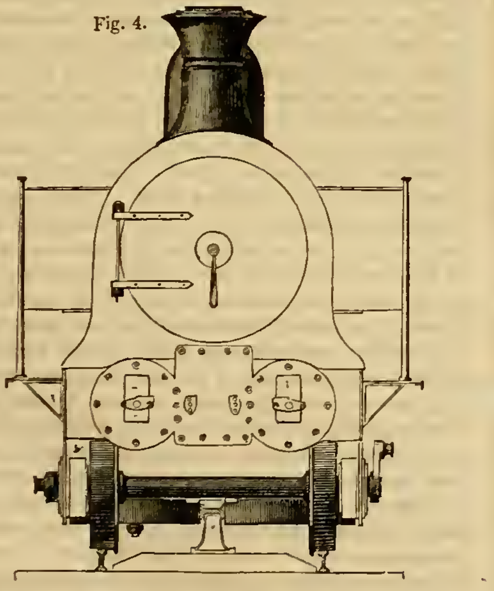


Fig. 3.

Fig. 4.



A little practice, and a graduated lever handle to actuate this, would have enabled the engine driver to ease his engine of all difficulty.

It has been recently once more stated that these difficulties have been overcome, and that not only is the line over the mountain prepared for the engines, but that very soon (viz., on the 17th May, 1868) the engines will be proved apt and fitted to the line, and the line be opened. We hope it may be so, for we wish well to a bold and interesting experiment.

The chances of the lines paying, however, a handsome profit upon the capital invested will much depend upon how soon it can be got into full use. The latest accounts given of the progress of the great tunnel point with a clearness and certainty to its time of completion, which show that a very few years, if we may reckon by so large a unit of time, will remain for the Fell line to have the traffic all to itself. It is still conceivable that once both tunnel and summit line shall be open together, the traffic may prove so enormous as to give full work for both; but we scarcely think the summit line can compete with the tunnel, once the powers of transit of the latter shall have been taxed to anything like what it can pass per day.—Ed.

SERICICULTURE IN FRANCE—RECENT IMPROVEMENTS IN PRODUCTION.

The history of silk is scarcely less curious than that of gold itself, and probably the future of the former will, in one respect, present a remarkable analogy with the recent history of the latter; for as gold, known from the remotest ages of human tradition, long was scarce in the highest degree, and yet, after the lapse of thousands of years, sources whence it has been, and is still being, obtained in unlooked for abundance have been unexpectedly discovered: so may we, with much probability, predict that silk, which in the time of Augustus (B.C. 20) was worth at Rome its own weight in gold, and so scarce that its use in dress was forbidden to those below patrician rank, is yet destined to become plentiful enough to compete largely with cotton and linen in clothing multitudes of the human race. Not only in beauty of texture and of sheeny brilliancy, as well as in its chemical qualities, which enable it to receive the most magnificent colours in the dyer's vat—qualities which have latterly found, as it were, their proper complement in the affinities of the grand series of the aniline colours as dyes for animal matter; but in the softness, strength, durability and slow-conducting power for heat, of silk fibre, does it proves itself the most suitable material yet discovered for the dress of mankind in all warm or temperate climates. The grand point is to get enough of it; and this, which has made but little progress or increase for ages, does seem now likely to have a future of vast accession in quantity before it.

Like many other great arts, the manufacture of silken fibres and silk cloth must have been known for ages in the remote East—in China, and perhaps in Japan—before anything was known of it in the then comparatively barbarous Europe. Though known as a product brought from unknown parts beyond the sea for the luxurious men and women of imperial Rome, and possibly known long before in the days of David and Solomon (B.C. 995), who established a great overland trade with the East; the actual nature, as well as the source of the silk, or Σηρικη, was unknown to Nearchus, the author of the Periplus of the Red Sea, about 330 B.C., who mentions it in the account of that early voyage of discovery. Silk was thus at least 400 or 500 years known in Europe while still brought, as a material of unknown origin, from the remote East in a manufactured state. The "Median robes" of the later Greeks would seem to point to its having come, in part at least, from Persia or Mesopotamia. The earliest notices of the true nature of the material seem to be those of Aristotle, about 330 years before our era, in his fifth book, who says it was the product of a worm first employed in spinning in the island of Cos; and of the historian Pausanias (A.D. 170 to 210), who gives a queer account of its production by an insect, which spun by wrapping the fibre round its feet. Up to the middle of the sixth century silk seems to have been supplied sparingly to the markets of the lower empire and to Rome from Tyre and Berytus (Beyroot), and as a manufacture silk was still unknown to Europe. Then, however, two Nestorian monks (it is wonderful what these prying, unscrupulous, restless, and intelligent early monks did for the transfer westward of discovery) brought to the Emperor Justinian at Byzantium accounts of the silk worm and silk manufacture of Persia, and returning from a second visit thence, brought with them, concealed in a cane, a supply of eggs, which were probably the progenitors of a large proportion of the silk worms that since have spread over Europe. Of a large *proportion only*, however; for the silk worm was introduced into Spain apparently by the Moors in the seventh and eighth centuries, and their stock, we may presume, came more directly from Arab sources, and through Palestine or Egypt.

The production of silk cloths in Europe must have been extremely small for at least 200 years after the Emperor Justinian's time. The Venetians appear to have monopolized most of the silk trade from the Levant, and probably from about the end of the fifth century; but it is not improbable that even before the ninth century there was a direct overland trade in silk from China. The grand sacerdotal robes given by Charlemagne to the cathedral of Aix-la-Chapelle, although said to have been gold-embroidered in Sicily, are formed of rich thick crimson silk cloth of a very peculiar sort of twilled texture, which was purchased by the emperor himself somewhere in his northern dominions. A commission of experts sent about three or four years ago by the Emperor of the French to examine these grand ancient vestments at Aix-la-Chapelle, are stated to have satisfied themselves that the silk fibre from which the cloth had been woven was Chinese. If that opinion be assumed as well sustained, it affords a strong presumption of the existence of the overland silk trade from the remote East into Europe, to which we have above referred; and thus at this remote era the early beginnings of that vast terrestrial trade between Asia and Europe had been begun, which now has marked the beaten highway for ages of the commerce between the sons of Shem and of Japheth, and which at present yearly culminates in the great fairs of Nishni-Novgorod or of Astrakan. Charlemagne seems to have had a great admiration for silken garments, which he not only employed for himself and for his courtiers, but of which he made many of his imperial gifts. In the year 870 he sent to Offa, one of our own Heptarch kings, a gift of a silken vest (woven without seam apparently) and a silken baldrick, either a sword-belt or a sash. The most costly product of that dark and barbaric time, however, was naturally possessed in most abundance by the richest man of his time in the Western world.

The conquering Normans, ever full of intelligence, order, and power, were soon alive to the silk trade in their acquired Mediterranean dominions. Very early in the twelfth century (1130) Roger II. of Sicily formed silk-breeding establishments and works for spinning and weaving both in Sicily and in Southern Italy; it is said, by help of captives brought back with himself from Palestine. In the thirteenth century the manufacture had grown to the dimensions of a staple trade in Italy, and was creeping into the South of France, where during the next century it became firmly established. But it was not before the early part of the sixteenth century that Italian workmen and silk-breeders were induced to come from Italy and settle in France; and it was not until 1565 that the propagation of the white mulberry, of which millions now dot the surface of the great valley of the Rhone only, to say nothing of the rest of the south of France, began to be pursued at Nismes. Henry IV. of France, though rather opposed than seconded by his great minister Sully, gave such encouragement as monarchs can to the mulberry culture, as the basis of that of silk.

Silk seems to have all been imported into England up to the time of Elizabeth (who is said to have been the first Englishwoman who ever owned a pair of woven silk stockings), if not even after that time. Her father, Henry VIII., wore silken hose, but there seems to be sufficient evidence that like the cloth hose long previously in use, his were cut out by the tailor's shears and sewn together. It is not devoid of interest that his daughter's rare woven silk stockings were made a present to her Majesty by Sir Thomas Gresham, the great London merchant and builder of the old Exchange, as a great rarity from beyond sea. Silk itself seems to have been known in England from about 1280, when it is mentioned in legal documents as well as in chronicles of the period. But in James I.'s reign, stimulated by royal recommendation in an edict, and by a speech from the throne of "the Scottish Solomon," a diffusive, if not vigorous, effort was made to introduce largely the cultivation of the mulberry with a view to silk. At a much later period (in Anne's time, we believe), attention was given to silk culture in Ireland; and at a subsequent date the earl of Cork caused considerable plantations of the white mulberry to be made in the south of Ireland with a view to silk: like many another attempt to introduce new industries in that country, however, it drooped and at last was dropped. It is stated in various places that most of the very old mulberries which are to be found still existing about the precincts of most old mansions, and of many ancient edifices in Great Britain and Ireland, were planted in consequence of King James' suggestions; but this scarcely can be other than a mistake. Many such old mulberries exist whose age can be with certainty established as long anterior to James' time—for example, that in the Fellows' garden of Trinity College, Dublin, now reduced to a few hollow limbs, which is known to have been a large old tree at the time when the suppressed monastery of All Hallowes was given by Elizabeth to be the domicile of her University *juxta Dublinensis*. Moreover, all these ancient mulberries, without exception, are the purple or white *fruiting* mulberry, whereas the white mulberry of the silk countries is a totally different species, and produces no edible fruit. It is quite true that the silk worm will feed upon either species; but the *Morus nigra* and *rubra* produce but one sure crop of leaves in the year in our climate, and in nothing like the abundance of those of the *Morus alba* with its two to four crops; and, moreover, if the fruiting mulberry be robbed of its leaves, it does not ripen, but sheds untimely its fruit. There can, therefore, be no doubt that those old trees were for fruit, and not for food for silk. That the black or red mulberry was a well known and an esteemed fruit, well known in England as early as Charles I.'s time, if not much earlier, may be inferred from an epigram more witty than decent, or one to be expected from the Puritan author of "Paradise Lost," which those acquainted with Milton's prose writings will recollect as occurring in his acrimonious controversy with Morus, upon whose name he puns in the epigram in question.

The *Morus nigra* is affirmed by Loudon to have been imported as a plant into England as early as 1548, from Italy, whereas the *Morus alba* was not introduced before the very last years of the sixteenth century, from China it is said, but far more probably from France, the mistake arising through China having been its native habitat. The *Morus rubra* came to us from North America in 1629. The great old mulberry of Lambeth Palace Gardens is said to have been planted there by Cardinal Pole in 1559, only eleven years after its first introduction. These facts, and the garden or orchard culture of the trees, seem conclusive as to their having been regarded as fruit trees, not as sustenance for silk worms, though they may have been occasionally used for the latter purpose.

Though the earliest mulberry nursery in France was at Nismes, the very first white mulberry tree known to have been planted in French soil is still to be seen near the old walls of Montelimart, in the south, where it has survived since the time of Charles VII.

As early as 1440, at Tours, then the residence of a court and one of the most advanced cities of France, the manufacture of native silk had made a good deal of progress, and Louis XI. managed to entice workmen from Lombardy to pursue it. Francis I., Henry IV., as already stated, and afterwards Louis XIV., as one of his magnificent tastes, aided by Colbert, on the more sober and sensible grounds of trade, greatly promoted the silk trade in his own dominions, and by the one iniquitous stroke of his pen which revoked the edict of Nantes, powerfully promoted the rise and growth of it amongst ourselves. There appears to have been before that really nothing worthy the name of silk manufacture in Great Britain or Ireland. The Flemish refugees of Elizabeth's time brought us our woollen manufacture, those of France in William and Mary and Anne's time that of silk; the Huguenots, amongst whom was so much of the best blood and brain of France, founded the broad silk trade of Spitalfields in London, and that of ribbon at Coventry, to both of which the silk-throwing mills of Derbyshire and Lancashire afterwards became tributary. Those who reached Ireland were the founders of the Irish tabinet or poplin trade in Dublin, which still survives, though, like that of the other British localities, not flourishing; for the relative growth and greater skill and excellence of the native French silk manufacturers have left them all hopelessly in the rear. Winkworth, a manufacturer of Spitalfields, deposed in evidence in 1857, that he estimated the capital then invested in the silk trade in England at £50,000,000, and that 1,000,000 persons were supported directly or indirectly by it. This surely must be a gross exaggeration, however, unless he includes the merchandise of silk goods as part of the silk trade, and even then it seems hard to credit that one-thirtieth of the population is supported in any way by silk. Whatever it may be amongst us, however, it has been, though not without great interruptions by war, civil commotion, and scarcity at times of the raw material, a constantly growing trade in France, where, as in Persia, China, and Japan, as well as in the Deccan and other parts of India, it constitutes now, as all nearly know, a vast staple industry.

The production of the silk itself, which is rather to be viewed as a branch of husbandry than of manufacture, is far more widely diffused than is the preparation into cloth, &c., of the fibre; but hitherto this husbandry has shown but little expansion. Silk farming, in the Crimea and Southern Russia, in some of the Danubian countries, and in Asia Minor, and other Moslem regions, supplements the great markets of Persia, India, and China, together with Southern Europe and Northern Africa. But notwithstanding much encouragement (as the phrase is) given to it by Frederick II. in Germany, and some considerable but not over-satisfactory efforts made in America (both North and South) and in Australia, the superficial area of silk farming does not much enlarge. The great reason of this appears to have been, if not still to be, that everywhere this farming was confined to that of one insect, the *Bombyx mori*, of the same species, if not the actual descendants, of those eggs brought from Asia. Whether it is that this insect is of a species peculiarly tender and delicate, and liable to great and epidemic diseases thinning off its numbers at times in a most disastrous way; or whether by long-continued breeding and culture the race has been degenerated; or whether our European climates and seasons have for a third of a century or so been passing through some cycle of change hurtful to their habits—upon these and many other and more recondite theories meteorological and physiological, doctors have and do still greatly differ. "The silk-worm disease," or *Muscardine*, like the *Oidium*, or "vine disease," has, however, within the above period more than once made itself felt, in such sudden and unpreventable reductions of the raw material, as to have produced great industrial distress in France, have greatly deranged and imperilled the manufacture, and caused the French government to look about with great anxiety for the means of preventing the recurrence of such insect murrains, or of otherwise increasing, and so steadying the supply of silk. Had it not been for these events silk might have remained for ever in Western Europe and America the clothing of the luxurious rich alone, though for ages it has been the staple clothing of a very large proportion of the populations of China and of Japan, in number equal to those of the whole of Europe, and in respect of poverty and destitution, in China at least, far below any European people. In those countries silk is the clothing of the poor as well as the rich.

The French government inquiries and researches constitute quite a silken literature in extent. They have been undertaken with that largeness of view, and with all the order and foresight, that exact thought and the purview of science can confer; and substantial encouragement and reward have been freely given to such individual efforts as have shown themselves worthy of it. The results as yet may not be very enormous, nor such as to have made any great mark upon the course of trade; but no one cognizant of the facts can fail to see upon reflection that the right key has been struck, and that the sound given forth tells distinctly, that the true course has at length been entered upon for making the future production of silk as much more abundant than the past, as the new insect sources discovered are stronger and more vigorous in nature than the old ones, and as the totality of all the sources of silk are become multiplied.

Silk is not only, as we said at the beginning, curious in its industrial history, it is in a high degree curious in all that relates to its chemistry and physics, and to its vital production. Mulder, the great Dutch chemist, who has examined it carefully, has shown that each silk fibre, though not more in diameter, in any variety of silk, than from $\frac{1}{2000}$ to $\frac{1}{1000}$ of an inch, consists of three superimposed layers; all of azotized but all of different organic materials. The external coat is tolerably soluble in water, especially if warm, and consists mainly of gelatine, and is in weight about $\frac{1}{5}$ of the whole raw silk fibre. Below this is a tube of albuminous matter, soluble in alkaline solutions, in vinegar, and in soapy water; and within this is a central cylinder of true silk. This when deprived chemically of the minute portion of animal oil, upon which its fine golden colour seems to depend, is quite colourless, and constitutes the pure chemical substance of silk or *sericin*. The ultimate constitution of this wonderful substance, which is identical with the fine colourless *silk-worm gut* of the angler, is given by Mulder as—

Carbon, ...	48·61
Hydrogen, ...	6·50
Nitrogen, ...	17·34
Sulphur and oxygen, ...	27·55
	100·00

It differs extremely little thus in chemical constitution from human scarf skin, hair, horn, wool, quills, tortoise shell, whalebone, nails or claws, hoof, sponge, and chitine, *i.e.*, the horny external skeleton, or cases, of insects. Sericin is insoluble in cold alkaline solutions, a fact upon which the unwinding of the fibre from the cocoons, by means of warm soapy water, is based; but it is soluble in strong sulphuric or hydrochloric acids, in solution of chloride of zinc, and in that of ammoniacal oxide of nickel, or of copper. Its specific gravity is 1·300. Constructively, *i.e*, as producing with a given weight of material the largest amount of resistance to a tensile strain, it is *the* most wonderful material produced in nature or by art. Pure silk fibre, and silk-worm gut of equal section appears not to exceed it in strength, requires a strain of 23¼ *tons* per square inch to tear it asunder. Cast steel is torn asunder by from 50 to 60 tons per square inch; and in fine wire may possibly reach 120 tons per square inch. But the specific gravity of steel is 7·8, as fine wire probably 8·0, whereas that of silk is 1·3. If, therefore, we employ the term *constructive modulus* to express this relation between the weight and strength, or $\frac{S}{P} = M$ that modulus, we find—$M_{\text{Silk.}} : M_{\text{Steel.}} :: 120 : 74$ or thereabouts. In other words, silk is weight for weight nearly double as strong as cast-steel wire.

All these organic substances are secretions, products of digestion, and the remarkable fact is that silk appears in all cases to be the result of digestion by the secreting caterpillar, of vegetable juices of a peculiar, and of a very limited character. Every plant supporting a silk-secreting animal as its natural parasite seems to contain juices, thick, ropy, more or less milky, capable of rapid oxygenation and inspissation on exposure to air, and more or less rich in caoutchouc, or in mixed substances more or less analogous to that and to gutta-percha, or to the natural Silhet varnishes of Nepaul.

It is not impossible that hereafter research may discover members of the vegetable world excreting silk, or some near analogue of it, directly; but so far, we believe, the only approach to silk there discovered has been in the *Pulu*, or vegetable silk of Sumatra, of which a few hundred pounds were imported to Liverpool about twenty-four years ago, about the same time that the wild insect silk of the jungles of Assam was there imported in cocoons, no solvent for which could for a length of time be found so as to admit of their being unwound. That difficulty, for the overcoming of which the Manchester Chamber of Commerce offered a reward, was vanquished by the late Mr. Schwabe of that city, then one of the most intelligent and accomplished men in the silk trade of Lancashire, and the dream of whose life was the production by chemical means of artificial silk in a state of solution, from which all cloths might be produced, and which should pass by at one bound all the difficulties of the silk harvest, as due to the help of insects. That he never lived to accomplish, though he did live to produce the most gorgeous tissues of coloured spun glass as another substitute for silk fabrics for certain purposes. The *Pulu* was said to be the floss-like down, which could be stripped off in abundance in the form of long golden fibres from the stems of the fronds of certain tree ferns indigenous to Sumatra. Might not the same substance in other forms be found upon the tree ferns that abound in Tasmania and other of our colonies? at least it is worth looking for.

The fact that animal fibres, analogous to those of the silk-worm of history, were produced by various other insects, was noticed at least as long ago as the days of Reaumur. Spider's web, which is identical with silk fibre, has been found to spin and weave sufficiently well to produce gloves and gauze; but those ravenous little beasts have also been found to attack and eat each other, so that they don't get on well as silk manufacturers. Reaumur found that various sorts of caterpillars produced a very tolerable silk, but it required the cocoons of 50,000 to produce a pound of silk, the fibre of which was not strong, and was excessively fine.

The project of rearing caterpillar silk was physically possible, in a commercial sense, but it had no chance of paying. And that, we may easily realize when we recollect that, with the far robuster and more copious silk of the *Bombyx mori* a single cocoon usually weighs 3 grains, and produces unwound 300 *yards* of fibre; that 12 lbs. of such cocoons are required to produce 1 lb. of reeled-off silk, the outside and short fibre being "floss silk." And again, we easily realize the quantity of provender the silk-worm needs to enable his stomach to sort out from the juices of his leafy food, and his curious economy to secrete, this pound of silk, when we find that it takes 1600 mulberry leaves, the average produce of sixteen trees, to rear 100 lbs. of cocoons, or one leaf crop of about 133 trees to each pound of reeled silk. The annual consumption of silk of Great Britain alone is about 10,000,000 lbs. of silk; a flight of locusts could scarcely make more havoc than is needed amongst the mulberries for their production.

No European caterpillar seems to present a prospect of success as a silk producer, unless it be that which infests the *Pinus maritima* in the south of Spain, France, Italy, and generally along the northern coasts of the Mediterranean. These orange and black banded strong reptiles in autumn envelope their whole brood in one immense cocoon, which hangs from the pine branches as large as an ostrich egg. The enveloping fibre is of amazing toughness, and nearly as large in diameter as that of the *Bombyx mori*.

We are not aware that any experiments have ever been made to utilize this product, but the writer of this paper in 1857 sent home from the neighbourhood of Marseilles to Sir Roderick Murchison several of these cocoons with the insects alive. The transport cost a considerable sum to the sender. The box and insects were sent by Sir Roderick Murchison to the British Museum, and there all trace of what became of them ends—one amongst many proofs of the want of some better accord and action between the authorities there and the men of experimental science, of natural history, or other studies. Several years ago, about 1820 if we mistake not, a Mr. Piddington brought to Malta (where some silk is still reared) eggs of the *Bombyx cynthia*, a powerful caterpillar (of Assam also, but not that which produced the wild silk) which feeds upon the great oily glandular leaves of the castor-oil plant (*Ricinus communis*), there a tolerably sized tree; but his success in the production of silk, or in the multiplication of this insect stock there, was not encouraging. M. Hugon and Dr. Helfer have given in the *Journal of the Asiatic Society of Bengal* a great deal of important information as to the various silk-secreting insects of Asia. The latter author has described seven robust species before unknown—viz., 1. The insect which is indigenous to the central (and probably northern) Indian provinces, and identical or closely allied to that of the wild jungle silk. It is not larger than the *Bombyx mori*. 2. The Iorec of Assam, *Bombyx religiosa*, whose natural food is the leaf buds of the Pepul tree (*Ficus religiosa*). 3. *Saturnia* (*Bombyx*) *Silhetica*, found on *Hologarnas*, and other varnish trees of Silhet and Dacca. 4. A huge insect, found by Grant in the province of Chirra Punjee, the moth of which is bigger than a bat, perhaps the largest of known terrestrial flying insects, and said to be 10 inches across the wings. Of the silk of this giant species little seems known. 5. *Saturnia paphia*, an insect found in the Tusseh jungles, and whose wild silk is collected and spun near Calcutta, and at Baghelpoor, to a large extent. 6. Another unsettled species of *Saturnia* from Kumercolle. The two last are said to be found mainly on trees of *Zizyphus*, *Terminalia*, *Bombax*, &c. 7. *Saturnia Assamensis*, the native name of which is *Mooga*, and feeds on two trees whose species have not been given, but whose native names are *Adakoore* and *Soome*. The cocoon of this is said to be as large as a hen egg, and the fibre to be of great diameter and strength. Besides these, there are known or employed as Indian species the *Arrindee* or *Eria*, *Bombyx arrindia* of Edwards, and *Saturnia trifenestrata*. The former is fed mainly on the *Palma Christi*, or *Ricinus*. All these species are tropical, and probably, if capable of living at all in the climate of Western Europe, would be found soon to degenerate.

The French naturalists have of late years studied, under the influence of government, the entomology of all the silk-producing animals with much care. Many projects for the introduction of new species, much information as to the nature, though still obscure, of the *muscardine*, or silk-worm disease, of the methods to prevent or cure it, and improvements in the *appareils* of silk farming, have resulted from these studies; the various memoirs containing the results of which, present a fine example of how genuine science ought to be employed in helping common arts and industries. Nothing that refers to animal life in any zoological collection perhaps exceeds in real interest the Pavillon de Sericiculture at the Jardin d'Aclimatization at Paris at present, where several of these new species of silk-worm may be seen in all their stages, each species carefully fed with its own special botanic provender.

Amongst those labourers in the field of economic entomology in France, none probably have effected results more important than those who have introduced two new species of great size and robust habit, and producing magnificent silk, which, although both natives of rather warm climates, yet seem perfectly capable of withstanding well that of even northern France. Indeed, from what has been already ascertained, and from the views expressed by competent Frenchmen, that even the north-west of France (Brittany) might now become a silk-producing country, there can be but little doubt that this new silk industry might, with every chance of success (so far as climate alone goes), be introduced into Devon and Cornwall, and into Cork county, Kerry, and possibly other portions of the south of Ireland. One of the new species from which much is expected is the Ailanthus silk-worm, the true *Bombyx cynthia*, as it has been identified by M. F. E. Guerin Méneville, an eminent naturalist, and the first introducer of the species from Japan to both continental France and to Algeria. This species feeds upon the leaves of the false varnish tree of Japan, the *Ailanthus glandulosa*, a large bipennate-leaved tree, allied to the sumachs (*Rhus*), which is found to thrive and grow rapidly in the parallel of Paris and south of it—indeed, almost anywhere in France not mountainous—and which grows almost as vigorously, without any protection, about London. Fine specimens may be seen at Kew Gardens.

It was only in March, 1859, that M. Guerin Méneville was able to announce to his countrymen that he had mastered all the conditions necessary to the life and culture of the new species with which he has endowed their silk industry, and since that he has been worthily honoured by the emperor with the cross of the Legion of Honour. Although trials with the *Bombyx arrindia* are still patiently in progress in Paris and elsewhere in France, as well as in Prussia, we believe great doubts are entertained by those best able to form an opinion that this species is likely to spread largely in Western Europe. At a future period, when the Southern States of America shall once more have reached some haven of peace and a social state fitted for the finer husbandries, such as that of silk, probably this silkworm may prove eminently adapted to Alabama, Southern Georgia and Florida, &c.

Another worm which appears to have a great future before it is the *Bombyx yama mäi* of Japan, which feeds upon the leaves of the Japan oak (*Quercus cuspidata*). This insect had been known to the Japanese for ages, and its culture is said to have been reserved in Japan as a close royal monopoly, the produce being wholly employed to form those royal robes whose unequalled lustre and gloss so many have spoken of. The exportation of the eggs of this valued species was forbidden under severe penalties, and, in fact, next to nothing was known about it or its silk until early in 1861, when the French fleet was in Japanese waters. About that period, M. Duchesne de Béllecourt, the *charge d'affaires* of France in Japan, succeeded in securing some of the eggs, forwarded them home to his government, by whom they were at once sent to the Société d'Acclimatization, who have produced the insects, and are now able to spread the species over France. This worm is an enormous brute, about 3½ inches in length, and fully three-quarters of an inch diameter across the middle. The moth is nearly 5 inches across the wings, the male being a grand gold colour, and the female a rich sort of (Bismark, as the ladies now name it) golden brown. The cocoon is not very large, though much greater than that of the *Bombyx mori*, but the animal seems free from delicacy or disease, needs little care, and the silk is of magnificent quality.

Besides these two, the *Bombyx cecropia*, from North America, whose proper food is a wild plum tree; the *Faidherbia Bauhiniæ*, from Senegal, feeding upon a zizyphus (the jujube probably); the *Bombyx Luna*, also from North America; the *Bombyx Atlas*, from the Himalayas, which feeds upon a barberry (*Berberis Asiatica*), have been or are under trial in France, but without very good prospects, as they either produce open cocoons and difficult to reel off), or live upon plants that will not thrive in our Western Europe. The Ailanthus worm and the Yama mäi seem to unite every desirable condition, and do almost seem to justify the sanguine view as to the remoter future of silk production expressed by M. Guerin Méneville, that hereafter the silk cloth woven from Ailanthus silk will come to compete in cheapness (when value in warmth, durability, and appearance are also taken into account) with cotton, and ultimately largely to supplant it as the ordinary clothing for the European population, as it has for ages been the clothing of the poor classes even of the Chinese.

We have already extended this notice to such length that it is impossible for us to enter at all upon the specialities, so far as these have been ascertained, of these new silk husbandries: for these we must refer to the able monographs which have been published by M. Guerin Méneville, printed at the imperial expense in 1859 at Paris; and that by M. Camille Personat, also published in its fourth edition at Paris in 1868; as well as to the "Entomologie Appliqué" of M. Girard, and indeed, as we have already said, to a whole bibliography of silk culture, the results of the labours of but a few years past. We in England are by habit very generally too slow to open our eyes to new sources of wealth and industry; we rather waken up suddenly to find others have discovered a new track, which we follow in, with our characteristic perseverance and energy, but often with but little of either insight or foresight. But as silk and its manufacture are already one of our own staple and now ancient industries, though in many respects sadly unprosperous, we have deemed it well thus to place before our manufacturing readers, as well as those of our landowners suitably circumstanced, what has been done in the way of advance abroad in silk culture. The notice we have given will, we think, justify the remark with which we started, that silk, like gold, after ages of scarcity, is now likely to have a future of vast abundance—one which cannot but have momentous social and commercial results.—Ed.

COIN AND COINING.

By Joseph Newton, Royal Mint.

(*Continued from page 359.*)

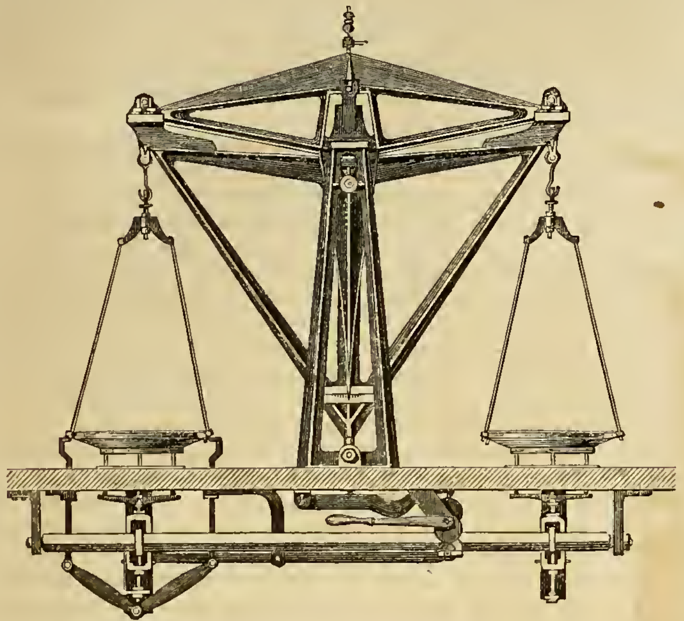
It has been stated that to Captain Harness was due the introduction of the automatic weighing machine at the Royal Mint. To Mr. James M. Napier, the celebrated engineer, of York Road, Lambeth, however, must be awarded some of the credit of perfecting the mechanical arrangement of the apparatus. The Bank of England—thanks to Mr. Cotton, one of its directors, now deceased—had previously adopted an automatic system for the detention and rejection of light sovereigns and half sovereigns, and this circumstance, no doubt, led to the introduction of a similar plan to the Mint. In order to make that plan efficient, it was essential that the balances of the latter place should not only separate light coins from those which were of legal weight, but take care also that none which were too heavy should pass into circulation. It will be readily understood that if the Mint authorities allowed coins to escape which were *above* the legal maximum weight, it would occasion a loss of the precious material to the establishment which would tell seriously upon its expenditure; if, on the contrary, they permitted light pieces to go into the hands of the public, the latter would be defrauded.

These exigencies demanded further complexity than was required in the Bank automatic machines. The Bank machines took no cognizance of *too heavy* coins; their objection only extended to those which were too light. Mr. Napier, at the instance of Captain Harness, solved the mechanical problem involved in the Mint requirements. Experiments carefully made in his own factory enabled him to do this; and when the machines there constructed were transferred to the Royal Mint, they were at once found to perform their delicate and onerous functions with unerring exactitude. At present there are seventeen of these silent but infallible pledges of the accuracy of weight of standard gold and silver coins in the Weighing Room of the Mint. The automatic balances appear almost to be endowed with the faculty of thought. They seem to deliberate, as it were, upon the character of each piece of money submitted to their arbitration, and to acquit or condemn in accordance with the evidence adduced. Each machine is placed on a low bench or table of planed cast iron, and at a first glance they might be mistaken for so many skeleton clocks covered by glass cases to protect their "works" from dust and humidity. In order to communicate motion to them, a line of small and brightly turned wrought-iron shafting, supported by neat pendants from the ceiling above, spans the whole length of the apartment. The shafting is placed immediately over the machines, and fine gut bands passing round pulleys descend to corresponding pulleys on the driving spindles of the machines.

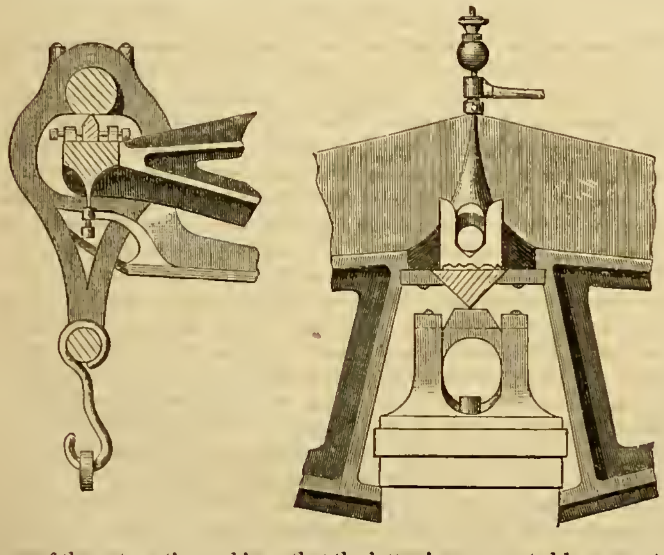
The lower series of pulleys are immediately outside the machine cases, through holes in which the spindles turn. A small brass weight and lever attached to each machine serves to tighten the gut band, so as to give motion to the coin feeding slides, &c., within the cases. Tiny friction clutches, adjustable by pressure of thumb and finger, allow of the engagement or disengagement of each machine at a moment's notice.

In a remote corner of the Weighing Room is placed the motive power. This consists of an atmospheric engine, which closely resembles externally a high-pressure steam-engine. It has its cylinder, piston, slide valve, governor, and fly-wheel. Beneath the cylinder, and forming the bed-plate upon which it rests, is a vacuum chamber of considerable area. This is exhausted by the Newton air-pump alluded to in a former article, and the extent of rarefaction within the chamber is controlled and regulated by a relief valve and barometer gauge. When this atmospheric motor of the automatic machines is required to be in action, a stopcock is turned, and a communication thus made with the air-pump. A stream of air from the room then rushes through a bell-mouthed tube of brass and presses upon the piston of the engine. The rotatory motion follows as if steam were the agent employed to effect it. The advantage of this arrangement is that a uniform rate of speed is obtained for the overhead shafting, by the intervention of a strap and pulley, and so for the automatic machines. Without that uniformity accurate weighing would be an impossibility. It has been remarked that "those who think twice before speaking once, speak twice the better for it," and it is as certainly exact to remark that the weighing balance which is allowed due time for acting will yield far more truthful results than that which is not. One of the great principles necessary to be observed in correct automatic weighing is regularity of motion, and another, deliberateness. It has been stated that the law of gravitation is infallible, and it is so; but it must be allowed fair play and freedom in time to insure that infallibllity. As the mind of a judge in a court of justice must, if his decisions are to be just, be alike unswayed by passion or by prejudice, so must the mute arbiters of Mint coins be free from disturbing causes of any kind if their conclusions are to be truthful.

Having thus, as fully as circumstances will permit, explained the various appliances for giving motion to the automatic machines, let us return to the batches of coins which have been transferred to the judicial department in which they are placed. We will suppose that fifty or sixty *journées* of sovereigns, stamped and milled and apparently fit for the business of active life, are about to undergo the final test of their fitness for duty, namely, that of individual weight. They are first weighed in the quantities named, by means of a large hand balance, an illustration of which is here subjoined. It is not necessary to speak further of this contrivance, the main parts of which, viz., the knife-edge and bearing plate of the same material, are shown in an enlarged form below, than to say that it is extremely sensitive, and reflects credit on its maker. The use of this primary weighing in bulk, is that it may furnish a check upon the few workpeople who are to feed the automatons and otherwise wait upon them when in action. Having noted minutely the actual weight of the whole importation of coins, the latter are forthwith distributed among the self-acting machines.



It will be seen, upon reference to the illustration on page 358,* of one of the automatic machines, that the latter is surmounted by a spout, placed at an angle, and supported by a strut. This spout or slide is the receptacle for coins, and in it they are placed in rouleaux. They rest in it until the machine is started, as described. Then a small plate of steel, below the base of the spout, advances and recedes at a speed of twenty times either way per minute. In its advancing movement it presses forward a single coin until the latter rests upon a tiny scale-pan, forming part of a fine steel rod, which is delicately poised, and so adjusted as to move the beam, or be moved by it, as it may be too heavy or too light. The rod and scale-pan are shown enlarged at page 357. Above the opposite end of the beam depends another rod (also seen on page first referred to), and this, terminating in a loop or cage at the base of the machine, sustains a glass counterpoise weight of the legal minimum weight of a sovereign. Below the cage, but not attached to it, is a miniature "stirrup," in which rests a piece of platinum wire (platinum is preferred for the purpose, because not liable to oxidation) of the precise weight of the legal difference, or "remedy" allowed as a compensation for imperfection of workmanship. During the three seconds which each coin is permitted to rest upon the scale its fate or fortune is decided. If its weight exceeds the legal point one iota, it naturally depresses the end of the beam upon which it has been placed, and as a consequence the other end is raised, and with it the stirrup and remedy wire. This is fatal. The slider presses forward another candidate, and this latter pushes the condemned coin off its seat and takes its place. The culprit falls through a flat brass tube, and is conducted into the "too heavy" recess below the machine, there to a await its punishment—a return to the crucible.



The lower orifice of the conducting tube is made to vibrate over three spaces or slots below, and these lead to the "light," "medium," and "heavy" compartments. At the instant the too heavy coin was dismissed into the tube the lower mouth of the latter was held by a mechanical finger, itself governed by the movement of the beam, over the innermost or too heavy slot. The succeeding coin may for illustration be supposed to err on the other side of the standard. In this case the glass counterpoise descends, the defaulter is detected, and summarily ejected into the condemned cell for "light weights." When an intermediate or medium coin is placed on the pan the beam maintains its equilibrium during the whole of the three momentous seconds, and the coin descends to the accepted chamber. In this way these automaton judges try, and either acquit or condemn all coins submitted to their judgment. They pursue the "even tenour of their way" from morn till night, and collectively are capable of deciding upon the characters, and awarding the destinies of 200,000 sovereigns per day!

They at once protect the master of the mint from the error of excessive generosity, and guard the public from imposition. It may, indeed, be observed of the system of automatic weighing at the Royal Mint, that it is as near an arrival at perfection as is possible. It is also economical in the highest degree, for, although each machine employed has cost more than £200, they have, to use a common expression well understood, *paid* for themselves over and over again.

From the careful manner in which all the antecedent operations are performed at the Mint not more than five per cent. of the coins weighed in the Mint balances are rejected by them. At the close of each day the whole of the coins in the weighing room are again weighed in "journies" at Oertling's balance—those which are "good" being sent forward for circulation, and the rejected going to the melting pot. Of the trial of the Pyx, and the manufacture of coining dies, something will be said hereafter.

(*To be continued.*)

CHABROL'S DISTILLING APPARATUS.

Distilling apparatus used for the purpose of separating two or more liquids varying in their degree of volatility are all constructed on the system of retrogradation. The vapour proceeding from the boiler is brought in contact with continuously decreasing temperatures, so that the least volatile parts are first condensed and then retrograde towards their original point of emission, whilst the vapour from the more volatile liquids continue their ascending course.

The apparatus of M. Chabrol, of Marseilles, of which the following is a description, is based on the same principles, but the extreme simplicity of its construction facilitates the application; and whilst it admits of readily obtaining products rich in alcoholic concentration, it is equally applicable to the distillation of pyroligneous acid, wine, and all other liquids containing alcohol, whether in a natural state or produced by fermentation.

The apparatus shown in figs. 1 and 2 is intended to be continuous in its operation. It is composed of a boiler, *a*, containing the liquid to be distilled, surmounted by a species of pedestal, *b*, which incloses the curved plates, *o*, and communicates with the condenser, G. The boiler may be heated either by an open fire or by a worm supplied with steam from a generator. A cock is provided for the purpose of regulating the degree of heat given out by the worm, *d*, the outlet pipe of which carries away the water produced by the condensation of the steam. *f* is the pipe used to fill the apparatus when it is not required to work continuously, and underneath is the discharge pipe provided with a cock, which, as is hereafter explained, admits of regulating the efflux of the liquid when working continuously. The boiler is also furnished with a safety valve and blow-off as ordinarily used.

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* *P. M. Journal*, Vol. iii., Third Series.

Fig. 1.

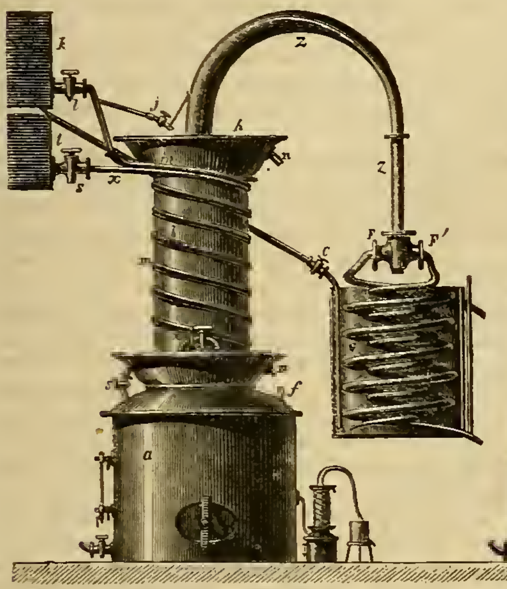
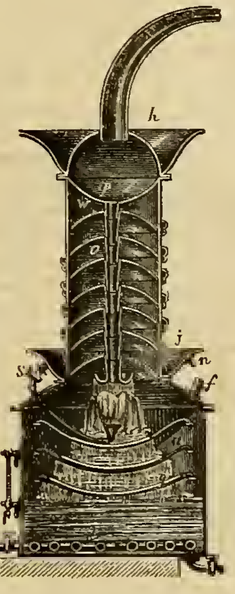


Fig. 2.



The pedestal, *b*, is provided with two receptacles, *h* and *i*, one at the top and the other at the bottom, intended to contain the condensation water. The upper one, *h*, is fed by the cock, *j*, communicating with a cold-water reservoir, *k*; the lower one, *i*, is fed by the cock, *l*, which receives water from the same reservoir, but the introduction pipe, *m*, is wound spirally round the pedestal, *b*, in order that the cold water before entering the receptacle, *i*, may be utilized for the condensation of the less volatile vapours carried away in the pedestal, *b*, so that the water is already heated to a sufficiently high temperature when it enters the receptacle, *i*. It will thus be perceived that the object of the cock, *l*, is to regulate the progress of the distillation, since it admits of augmenting or diminishing at the will of the distiller the retrogradation of the liquids which have not yet attained to a sufficient degree of purity in the apparatus. The receptacles, *h* and *i*, are each furnished with an overflow (*trop-plein*) pipe, *n*, at their upper part, to allow the warm water to run away in proportion to its arrival by the cocks, *j* and *l*. In the centre of the curved plates, *o*, are sockets, *p*, slightly conical in form, so that the lower end of each of the sockets fits into the top of the preceding one, so as to form a continuous pipe in the centre of the pedestal, *b*. The lower plate, which supports all the others, is secured by bolts to the cover of the boiler, *a*. The top plate, *r*, is curved in the opposite direction to the others, so that the liquid proceeding from the condensed steam at this top part of the pedestal in contact with the water of the receptacle, *h*, may run direct into the central tube formed by the sockets, *p*, and thence into the boiler.

In order to prevent any direct communication being formed between the boiler and the top part of the pedestal, the lower end of the central tube enters a small bowl, which is quickly filled by the condensed liquid, and from whence it runs into the boiler. The plates, *o*, are in contact with the pedestal, *b*, but apertures are formed in their periphery, which admit of the passage of the steam in its ascent round the sides of the pedestal, and of that of the condensed liquid in its downward course into the boiler. The vapour, after being diffused in the receptacles formed by the plates, is forced into contact with the sides of the pedestal, *b*, which is constantly cooled by the wine and condensation water passing into the spiral tubes, *m* and *x*. The advantage of this arrangement is that the poorer and therefore less volatile vapours are condensed, and the liquid thus produced descends to the lower part of the apparatus.

The wines or liquids to be distilled are conducted from the wine reservoirs, *t*, through the cock, *s*, and pipe, *x*; the latter, as well as the pipe, *m*, which conducts the water into the lower receptacle, *i*, is wound spirally round the pedestal, *b*, and enters the boiler, where it terminates in a rose, so that the liquid on its arrival is reduced to the form of a jet, which is immediately heated by the poorer vapours which are condensed and descend into the boiler. The cock, *s*, for the introduction of the wine, serves like the inlet cold-water cock, *l*, to regulate the operation of the apparatus, and admits of obtaining liquors in a more or less pure and concentrated state, and also of entirely utilizing the liquid introduced; it is only necessary to intercept the admission of the wine and close the discharge cock, *g*, to insure the ebullition of the liquid contained in the boiler, and carry off in the state of vapour all the rich and volatile products.

The top part of the boiler is provided with three basins, *y y′ y″*, one above the other, and of different dimensions, so that the liquid introduced by the rose, *u*, on entering the first basin, *y*, runs over and falls in the form of a cascade into the second basin, *y′*, of larger size, and from thence into the third, *y″*, still larger than the preceding. The advantage of this arrangement is that the liquid to be distilled being already heated in the arrival pipe, *x*, by its contact with the pedestal, *b*, becomes rapidly heated by falling into the basins, *y y′ y″*, and enters in a state of ebullition the boiler, *a*. The vapours sufficiently purified, on their arrival at the top of the pedestal, *b*, escape through the tube, *z*, which conducts them to the condensing worm, G. The latter is inclosed in a trough which is kept constantly supplied with cold water by means of the cock, C, and is provided with an overflow pipe. The end of the tube, *z*, carries a three-way cock, F, which admits of the vapours being conducted into one or other of the condensing worms, G, so that the products of the distillation may be divided, each worm being in communication with a separate receptacle.

It will be observed that there is disposed near the boiler a small trial distilling apparatus, in all respects similar to the other, the object of which is to enable the operator to ascertain at any time the progress of the distillation in the principal apparatus. When it is ascertained that the liquid in the boiler still contains some traces of useful products, the overflow pipe is closed, and the ebullition produced carries off the last traces of the alcoholic liquors which may be remaining in the boiler.

LANGLOIS' MOVABLE BOILER TUBES.

We translate the following from the *Propagation Industrielle* as worthy of notice amongst the interesting objects of the late Paris Exhibition:—

M. Sonolet, engineer, of Cherbourg, exhibited a set of boiler tubes, the invention of M. Langlois, chief constructor of the French navy, who has the charge of the boiler factory at Cherbourg. The chief peculiarity in these tubes is that each one is rendered movable, whereby the inspecting and cleaning of the boiler are greatly facilitated, and may be performed more frequently than usual, thus preventing the accumulation of deposit. The idea of making the tubes movable had its origin in the inefficiency of all chemical processes hitherto proposed to prevent incrustations. The same idea has been carried out in various ways; thus whilst M. Langlois renders each tube separately movable, MM. Farcot arrange their boilers so that the whole set of tubes are capable of being removed bodily.

The ordinary method of fixing the tubes consists in turning down their extremities in the form of flanges over the holes bored for this purpose in the boiler plates, and securing them by means of ferrules tightly driven in, sometimes even depressing them so as to form a projecting flange inside the plates. This method of fixing renders the removal of the tubes a very difficult and laborious operation; for in order to effect this it is requisite to cut off their ends, and to make a groove (at one end at least) to lay hold of each of them: in addition to which, as the tubes become coated with calcareous deposit, which daily increases in thickness, their diameter becomes greater than that of the holes in which their ends are secured, and consequently they cannot be removed without successive shocks, which are alike detrimental to the tubes and to the plates of the boiler. The result of all this is that the tubes are removed only at very long intervals.

Now the layers of incrustation increase very rapidly in thickness, and its non-removal exercises a greater influence on the quantity of steam generated in the boilers than many persons are yet inclined to believe. On examining ships' journals kept by the chief engineers, we find that during the first three months working, boilers produce about the same quantity of steam as at the commencement; that in the three following months (the consumption of fuel being the same) the quantity generated is only about 80 per cent. of what it was at starting; and that after one or two years' working it falls to 75, and sometimes even to 70, per cent. of what it was originally. The statistics from which we borrow these figures prove that the engines were in such a condition as not to require any augmentation of steam; the difference, therefore, can only be attributed to the deposits and incrustations which are continually being formed.

Fig. 1.

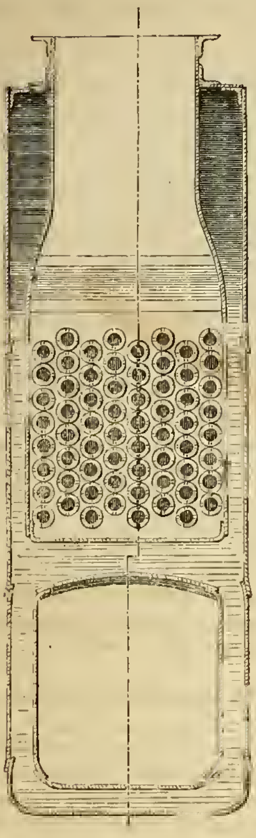
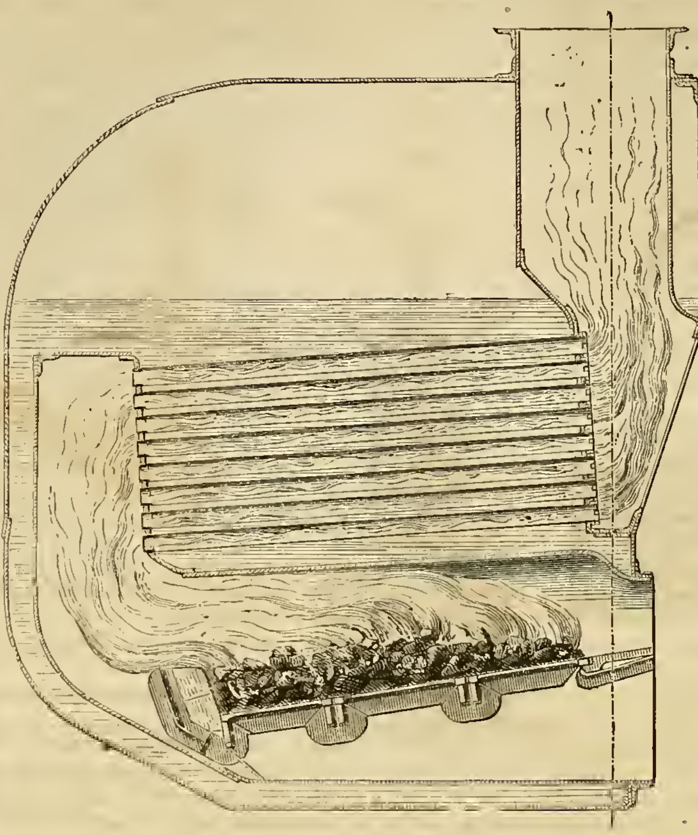


Fig. 2.



The following results of observations made on three vessels of the French navy, in reference to the produce of the boilers at different periods of service, will not be without interest to our readers. Experiments were made on the *Dupleix*, a corvette of 400 horse-power, during a run of 3347 hours. For the first 500 hours the consumption of coal was 765,760 kilogrammes, corresponding to 1,478,020 revolutions of the screw; during the remainder of the run it was 4,935,912 kilogrammes, answering to 7,671,700 revolutions of the screw. The *Bellone*, a frigate of 200 horse-power, was observed during a run of 857 hours; for the first 500 hours the consumption of coal was 355,754 kilogrammes, corresponding to 1,210,576 revolutions of the screw; and during the remainder of the run it was 446,790 kilogrammes, for 1,203,720 revolutions of the screw. The *Nièvre*, a transport ship of 160 horse-power, consumed during the first 500 hours 408,358 kilogrammes of coal, corresponding to 1,571,232 revolutions of the screw; and during the remainder of the run, say 2396 hours, 2,304,898 kilogrammes, giving 7,200,920 revolutions of the screw. These observations were made with great care.

If we wish to estimate from these figures the influence exercised by incrustations on the evaporating surfaces, we see, taking the first example, that during the first 500 hours of the run the consumption of fuel per hour and per horse-power was 3·829 kilogrammes, whilst during the 2847 hours following it was 4·334 kilogrammes; say, in all, an increase of 618,468 kilogrammes in the consumption of fuel, corresponding to an augmentation of 1253 kilogrammes per 100 revolutions of the screw. Also that during the first period of 500 hours the screw made 2956 revolutions per hour, whilst during the latter period it only made 2694, which is not of less importance from another point of view. The effects of incrustations on the tubes of boilers, whether locomotive, portable, or fixed, are obviously the same.

Fig. 3.

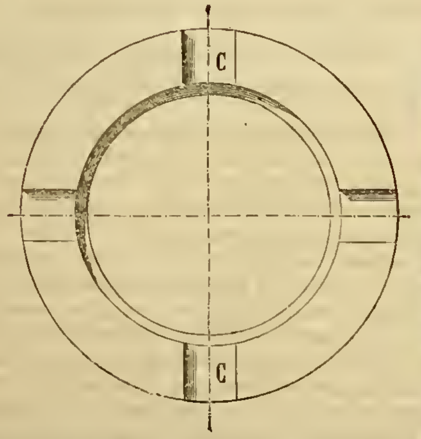
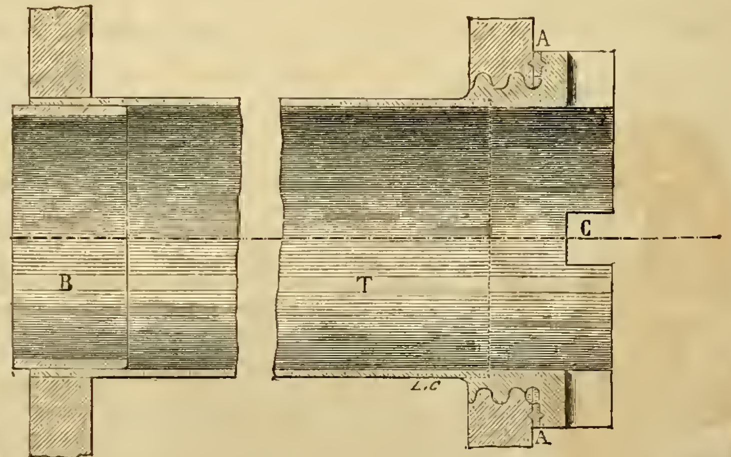


Fig. 4.



Having given these statistics, in passing, by way of illustrating to how great an extent incrustations are detrimental, we now proceed to lay before our readers M. Langlois' method of obviating these defects. Figs. 1 and 2 of the annexed engravings show the application of the system to a marine boiler, and figs. 3 and 4 are respectively an end view and longitudinal section of a separate tube, showing the mode of securing it to the boiler plates. This system consists in brazing on or otherwise attaching to the tube at the smoke-box end a piece, A, which has a screw thread formed on a portion of its circumference, and is screwed into the tube plate. At the fire-box end, the end of the tube simply fits into a cylindrical hole, where it is secured by a slightly conical steel ring, B, which also renders the joint tight.

When the tubes are mounted a small lead washer is interposed between the plate and the shoulder of the piece, A, which is provided with indentations, into which the washer is squeezed by the pressure of screwing up, which is effected by means of a spanner provided with keys to enter the recesses, C. The thread of the screw, as well as the other end of the tube and the ring, B, are coated with a composition composed of tallow and very fine zinc powder. After the furnace has been lighted some time the tallow disappears, and the zinc powder remains, which is an efficient preventative of oxidation. The connection of the tube at the fire-box end is effected by means of a mandrel, composed of four conical segments, in the centre of which is a quadrangular bar which forms a wedge. The ring is driven into this end of the tube by the aid of another cylinder formed in one piece, the front portion of which is made an easy fit in the ring to prevent any motion of the mandrel during the operation. Such cylinder is also provided with a shoulder which bears against the end of the ring when the blow is applied to drive it in, in order to secure the tube.

The rings are removed, for the purpose of taking out the tubes, by the aid of an instrument consisting of an arched piece which is supported on the outer side of the boiler plate, and has in its centre a screw, terminating at its lower part in two jointed hooks, which approach one another so as to enter the tube, but open out by the action of a spring behind the end of the ring, so that the ring is extracted with them when they are withdrawn by the rotation of the central screw.

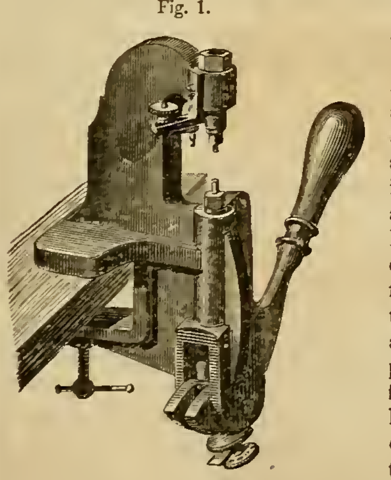
In order to obviate the difficulty which is usually experienced in withdrawing the tubes, by reason of the increase in diameter produced by the accumulation of deposit, M. Langlois makes the tapped holes in the plate at the smoke-box end about half an inch larger in diameter than the tubes themselves, which allows ample clearance for their extraction. In consequence of the firmness with which the tubes are held by the screw thread at one end, and by the conical form of the rings or ferrules, with the pressure they exercise at the other end, they perform the office of tie-rods by maintaining the rigidity of the plates.

This system is stated to have given very satisfactory results, and is, it is asserted, preferable to the plan before referred to, of removing the set of tubes bodily, as it has the advantage of facilitating the inspection of each tube. The time required to set and to take down a tube scarcely exceeds five minutes.

LIGNIEL'S EYELET MACHINE.

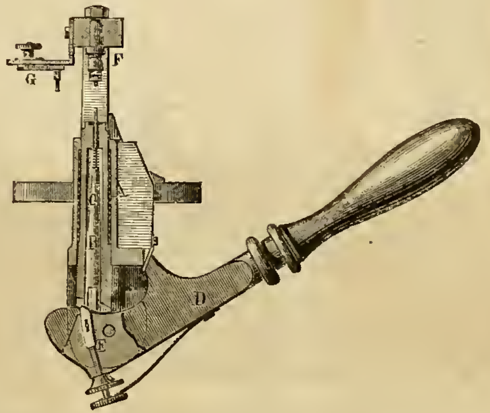
The annexed cuts represent respectively a perspective view and vertical section of a useful little machine for affixing metal eyelets, the invention of M. Ligniel, of Paris.

Fig. 1.



This machine, which is about 10 inches in height, consists of a cast-iron frame, A, which may be secured to a table, and forming in its axis a sheath to receive a socket, B, the object of which is to clinch the eyelet as soon as it is deposited in its place. In the socket, B, there is inclosed a rod, C, which performs, in conjunction with the hollow tube, F, situate above, the function of a punch, in piercing the hole for the reception of the eyelet. These two rods, B and C, are elevated by depressing the handle of the piece, D, which piece is hollowed out in the middle towards its end so as to form two cheeks, the upper surfaces of which being made of a suitable curved form, act as cams on two corresponding cheeks formed on the socket, B, in the same manner. A similar cam, E, produces the same effect on the central rod, C. With a view to adjust with nicety the amount of projection of this cam, and to compensate for its wear as well as that of the top part of the rod, C, M. Ligniel does not cast the cam, E, in one with the piece, D, but forms it of a separate rod having a screw thread cut on a portion of its length, and secures it in its place by the aid of a milled nut and a spring, the end of which is provided with a small pin which enters one of the holes disposed round the head of this screw and prevents it from turning accidentally. The form of the cams, D and E, is so arranged that the rods, B and C, are elevated together equally until the latter comes against the tube, F (at this moment the hole is pierced and the waste passes into the tube); as soon as the rod, C, has arrived at this point, the cam, E, ceases to act thereon, and the socket, D, continues alone its ascending course to clinch the eyelet. So soon as the handle is released, the pieces regain their original position for the affixing of another eyelet.

Fig. 2.



With a view to regulate invariably the distance between the eyelets, M. Ligniel has adapted to his machine a guide, G, which is simply composed of a rod capable of sliding in a groove disposed in the top part of the apparatus, and of being fixed at any point of its stroke by the aid of a pressure screw; this rod carries at its extremity a small pin (as shown in the engraving) on which the eyelet to be affixed is placed, so that its distance from the next eyelet is invariably determined. The distance between the central rod, C, and the pin of the guide, G, may be of any length desired, the latter sliding at will.

It is stated that this machine, by depositing the eyelet at the same time that it pierces the hole destined to receive it, effects a saving in time of 50 per cent. over the ordinary means employed, whilst dispensing with the use of pincers or awls; at the same time by the guiding arrangement increased regularity in the work is obtained.

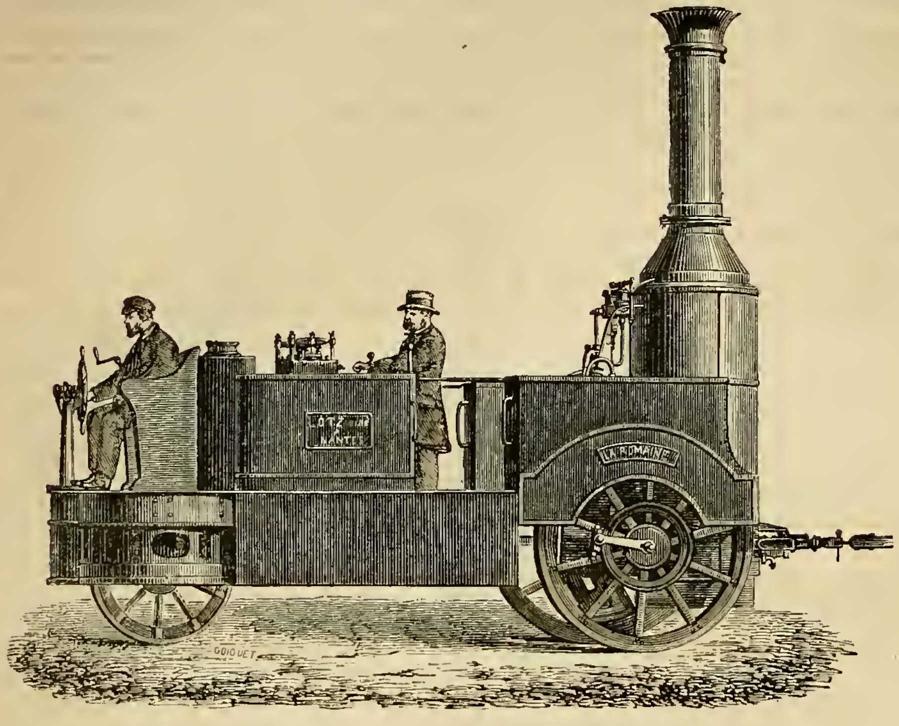
LOTZ'S TRACTION ENGINE.

The subject of steam traction on ordinary roads continues now to engage attention, and great efforts are being made to bring road locomotives to the greatest perfection of which they are capable. Nor need this be matter for surprise, for it vitally concerns both commercial, agricultural, and manufacturing interests; the only available means of transport being railways and canals. As to the latter, owing to the great influence required for their construction, their number is necessarily very limited, especially in those countries where from their topographical position gigantic works are involved in their execution, whilst the transit is not so rapid as in many cases would be required. With regard to railways, the enormous expenditure which their construction frequently entails necessarily confines them to the connecting of large centres of population and production, whence it results that some districts are wholly devoid of means of transport.

Transport by animal power has long since been pronounced wholly inadequate, and the need of a new system, capable of supplying the want in the present available means of transport, is universally recognized.

As every effort, made with a view to solve this problem, should be recognized, we lay before our readers a description of the traction engine, as arranged by M. Lotz (see engraving), which has been submitted to severe tests in the presence of the French Government Commission appointed to investigate the question of steam traction on common roads.

The whole of the apparatus is mounted on two frames extending along the side of the engine, which support the engineman's platform, and carried by the springs of the trailing wheels, and of the movable guide wheel in front. On the framing are two water tanks, one being in the fore part behind the steerer, and the other under the engineman's platform. The coal boxes are in the front of the frame and on each side of the boiler. The boiler is of a vertical form, in order to prevent the shaking produced by unevenness of the road from affecting the level of the water; it is provided with an internal furnace, the flames taking a winding course, and is disposed at the back, and secured by bolts to facilitate its removal. The engine is also vertical, and is situate at about the middle of the frame with a single cylinder, the latter rests on three iron columns attached to the foundation plate, so that the apparatus can be removed in one piece if required.



The engine is reversed by a slide on Stephenson's system, and the piston transmits motion through a strong forked connecting rod to a crank shaft, on which are fixed the two eccentrics and three pinions of different size, which, by means of three other gearing wheels, actuate an intermediate shaft, carrying at one end a toothed pinion, over which is passed an endless pitch chain, which, passing also over a toothed wheel fixed on the axis of one of the driving wheels, communicates motion thereto. Means are provided by which the engineer may instantaneously throw in or out of gear either of the three sets of gearing of which we have spoken, and thereby accelerate or retard the progress of the locomotive without changing the speed at which the engine works, and, thus, either the power may be augmented by one-third or one-half, or the velocity of the vehicle increased in the same proportion, according as the gradients, state of the road, and the load to be drawn may require. By changing the toothed pinion over which the endless pitch chain passes, an operation which may be effected in the course of an hour, three other variations in the speed may be obtained, so that the engine can travel at a high velocity with a light load, and at a diminished speed when heavily laden. A simple means is provided by which the length of the chain may be increased or shortened, as required. A wheel fixed on the driving shaft of the engine gears with a pinion (the proportion between them being as two to one) keyed on to a third shaft parallel to the other two, and carries a governor at its extremity, which thus, turning at double the speed of the engine itself, enables it to overcome the ruts which may occur in the road, especially during a wet season.

The two large driving wheels are made of sufficient size not to injure the road; their axle passes under the front part of the fire-box, the bearings being in movable boxes, suspended by strong springs to counteract the effects of the inequalities of the road. One of these wheels, as we before stated, is driven by the pitch chain, which, in most cases, gives sufficient adhesion; but on ascending a steep gradient the other wheel may also be driven, if required, by throwing into gear by a clutch lever, and the two wheels are then virtually fast on the axle, and the adhesion is doubled.

The steering wheel at the fore part of the frame is mounted on a pivot turning in sockets which are secured to a strong spring: it is worked by a toothed wheel which moves in a circular guide, and which is actuated by means of a pinion gearing into it, and mounted at the lower end of a vertical shaft, motion being transmitted to it by the steerer, by means of an endless screw working in a worm wheel on the top of the shaft, according to the direction in which the engine is required to be turned.

The entire engine is capable of turning round in a circle of little more than 30 feet in diameter, and with a train of four or five wagons easily passes round corners at a right or even acute angle, all the vehicles following it in the same track.

One important feature in M. Lotz's engine is the distributing the greater part of the weight on the hind wheels, whilst the fore wheel has comparatively little weight to support. By this means a high speed and increased adhesion are readily obtained.

Each engine carries an adequate supply of water for a journey of 12 miles, at a high velocity, and sufficient coke to last half a day.

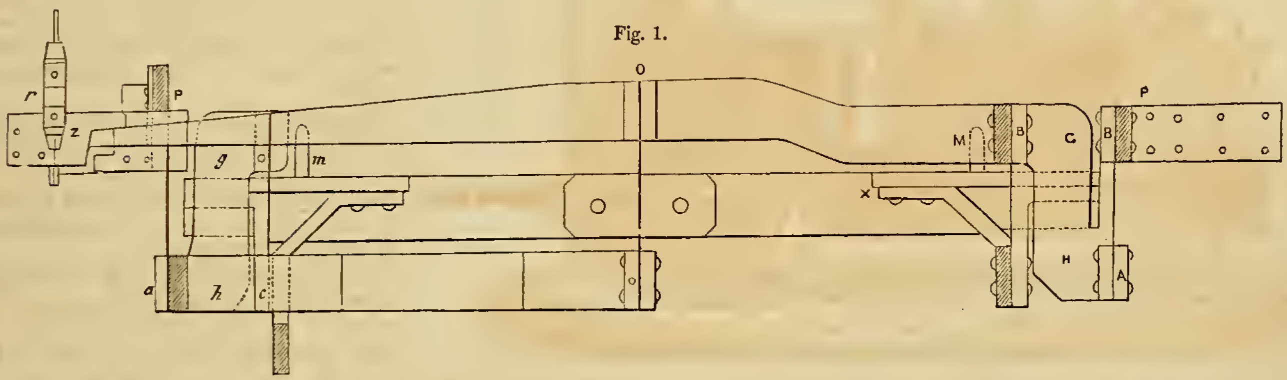
THE SPRING BALANCES AND DYNAMOMETERS OF M. DE TAURINES, OF PARIS.

In the great zone of the Exhibition building at Paris last year, amongst the miscellaneous machinery of the French department, stood some machines of most unpretending exterior, challenging no admiration from the mob, noticed or known but to a very few, but constituting in reality some of the most scientific and interesting objects of a mechanical description in the entire display. These were the spring-couple balances and dynamometers of M. de Taurines, a French gentleman, who, though not very widely known, has established a sure reputation amongst his own countrymen for the success and skill with which he has worked out to various important ends a single thought; namely, the conception of how a spring couple—that is to say, a couple whose applied forces are the resilience of a spring consisting of a flat laminum of steel, and an external force, the direction of which is not necessarily transverse to the laminum when bent, but in a tangent somewhere to its curvature, and so approaching to the direction of its length—may be employed in mechanical combination to many useful ends, more especially to any of those in which the measurement of the external force applied is concerned, by reference to the space described in flexure by one extremity of the spring laminum, or by that of the tangent to it prolonged. The chief applications he has made of this, which in some sense may be called "a principle," are to weigh-bridges and balances of all sorts, big and little, and to totalizing dynamometers.

A little way off from the gangway at the inner circle side of the great machinery zone, where these objects were shown, one who was duly directed to the place (as we had the good fortune to be by M. de Taurines himself) might see a very humble-looking weigh-bridge of moderate size, that without such guidance few would see at all, or, seeing, bestow a second glance upon. This little weigh-bridge had a platform upon which a man could stand, and it could weigh up to 400 or 500 kilogrammes, looking very much like a common weigh-bridge upon one of our railway platforms for luggage, &c. Under the guidance of the inventor we placed ourselves upon the platform in a standing posture, noted our personal weight in Parisian society, in kilogrammes, as shown by a revolving index hand upon a dial of some 8 or 9 inches diameter, and remarked with a little misgiving that the well-known good living of the Parisian *cuisine* had not prevented hard work pulling down our weight by some 2 or 3 kilogrammes. This was, so far, nothing new or marvellous. M. de Taurines, however, now said, "Stand quite steady upon the platform; place your fingers upon your own pulse at the wrist, and watch the index hand." We did so, and in a few seconds saw with no little surprise that the index hand vibrated very sensibly, with an alternate movement that kept perfect time with our own pulse. We fancied this might be some delusion, and placed a dead weight of matters at hand upon the platform, to see if the vibration of the floor, by reason of all the machinery whirling round about, had anything to do with the appearance, but no; though the hand had a quick and all but imperceptible tremor from this cause, it had no dipping, isochronal movement as it had before. We then asked M. de Taurines to be so good as to mount the platform, and to permit us to feel and count *his* pulse whilst we observed the hand. He did so, and we soon remarked that the index kept accurate time with his pulse, which beat much more slowly than our own. There remained, therefore, no possible doubt that the sensibility of the weigh-bridge was such that it most distinctly indicated, when loaded with about 156 lbs., the extremely small work of the heart, as at each pulsation it propelled the blood through the arteries, or rather the mere difference in the dynamic resultants of the column of blood propelled upwards and downwards at each *systole* and *diastole* of the heart.

The fact was surprising enough; but that was increased when, on questioning the inventor, we learned that, however sensitive, such weigh-bridges as these were perfectly simple in structure, were manufactured by him as a matter of commerce, were perfectly durable—much more so, in fact, than the ordinary ones consisting of a combination of levers adjusted to each other by steel bearings and knife edges—and were extremely small in first cost. We certainly then saw with great interest the internal structure exposed to us and described by the inventor himself, who has received for his machines one of the grand gold medals of the late Exhibition. The following description of the construction and principle is abridged by us from one given by the inventor himself, and is illustrated by diagrams taken from his own:—

Fig. 1.

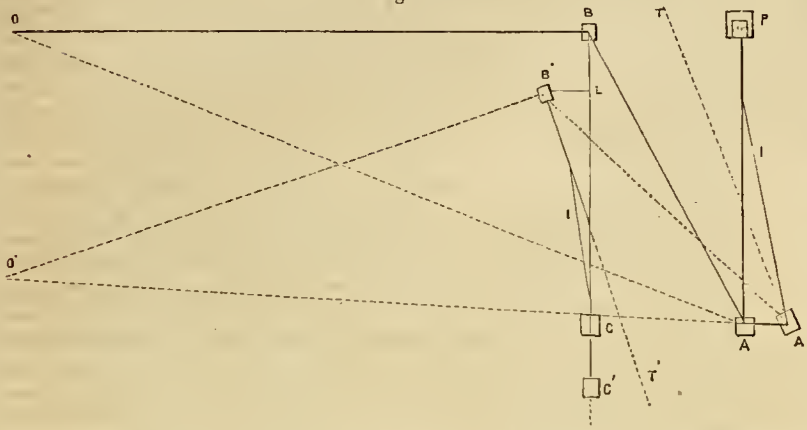


The arrangement of "elastic couple" is a new combination of straight springs acting upon rigid pieces, and gripped (*encastrés*) by their ends; the effect of the combination being to increase the amplitude of the motion much above the degree which is obtained through the usual applications of the properties of springs, and they are also by that way less severely strained for obtaining the same result. The spring arrangement (*couple élastique*) is composed of a first spring or lever, P A (fig. 1), invariably fixed into a piece, itself fixed in space; A, the lower part of it, is equal to the end of the stiff piece, A B, which we will call the diagonal of the couple; a second spring, B C, parallel to the first one, is fixed at the point, B. Its lower end, C, is not free; it is subjected to move vertically, because the piece to which it is fastened, in virtue of its own fixation, keeps always the same direction. These two springs or levers, P A, B C, have the same width and the same thickness, but B C exceeds P A in length about as much as the point C descends in the maximum work of the couple. The diagonal, A B, extends horizontally as far as O, in order to form the great lever of the system.

Mode of Action of the Couple.—If we apply now a power to the point, C, the piece which is connected to the lower end of the second spring always maintaining the vertical direction, and remaining always at the same horizontal distance of the primitive direction, P A, of the first lever; the point, C, comes to C′. The second lever bends, and produces a transverse flexure, L B′. If we draw a line, B′ T′, a tangent to the end of the curve, C I B, and take a line, B′ A′, of the same length as B A, and forming with the tangent, B T′, the same angle as B A with B C, in the original position, then the point, A′, will be the new position of the point, A, and the first lever will form a curve, which has for tangents the line, P A, and the line, A′ T, parallel to B′ T′. The great lever, B O, will have taken the position, B′ O′, and the figure (fig. 2) shows how great the deviation of the point, O, is in relation to that of the point, C. For example, in a weighing machine the table which takes the load descends as much as the point, C, 5 millimetres at most, but the deviation of the end, O, goes as far as 75 millimetres, or as 15 : 1. The important peculiarity of this arrangement is that it enables us to construct with very small springs a very powerful apparatus, occupying very little room, and that because the flexure of the springs is due to a force, acting not in a direction perpendicular to, but in a direction parallel to their planes; and it is easy to understand that we may increase the force of the elastic couple simply by bringing the two plates, P A, B C, nearer together, without changing their thickness, which is the same in result as shortening the arm of the lever which produces the flexure.

Applications.—M. Taurines is the inventor of a great number of spring-lever apparatus which have been proved in practice. In 1851 he produced at the Exhibition in London a dynamometer for revolving machinery (*dynamometre de rotation*), which obtained the council medal. At the Exhibition in 1855 of Paris a medal of the first class was awarded to him for his dynamometer, applied for measuring the resistance of the hulls of ships in water. By means of these it was possible to measure the power exerted by engines of from 700 to more than 2000 horse-power of 75 kilogrammetres (marine engines), to find the laws of the resistance of vessels, the useful effect of the screw propellor, upon which subject he had made numerous and remarkable experiments, published in "Le Mémorial du Génie Maritime," and to solve other dynamical problems. It will be seen that, notwithstanding the application of springs, this weighing instrument has no analogy with the older spring balance or weighing machines dependent on the decreasing deflexion of springs which yielded less and less as the load increased, and which can only give inexact indications, and difficult to ascertain, and in consequence of the gradual diminution of the power of the springs these are susceptible of errors after a certain time of use. On the contrary, in the elastic-couple weighing machine here referred to, by reason of the novel particularity of the arrangement, whose elements are combined and coupled two by two in the contrary direction, in a manner to oppose their deflexions and to compensate their respective energies; and as the deflexions themselves are also circumscribed within very narrow limits, the result is that their partial amplitudes are nearly proportional to the loads which produce them. We may therefore conclude, *à priori*, that equal divisions marked on the dial-plate, between the zero from whence the needle starts when there is no load on the table and the point where it (the needle) arrives under the heaviest load, which may be called the calibre or range of the weighing machine, will indicate approximately the successive weights applied and corresponding to their figures. It is, nevertheless, safer, after having marked the zero and the extreme figure of the scale, to determine some intermediate points by direct trial, which avoids any mistakes which might have happened from want of absolute equality of the deflexions. As regards any fear as to the gradual change of elasticity of the springs, we may state that M. Taurines appeals to his own long experience to the contrary. The whole of the springs which he has constructed for his different apparatus would possess in amount an aggregate resistance of 600,000 kilogrammes. Some of his dynamometers have been in use for several years, and with unaltered success; and, in particular, as regards his weighing machines, it has been ascertained that, being submitted to their full load during from twenty-four to forty-eight hours, and to such trials constantly repeated during a period of more than six months, he could not observe at the end the least alteration of the elasticity, or change of indications due to that ordeal.

Fig. 2.



We may remark that for small weights, as in the cases of office or postal balances, or chemical balances, the springs employed are very light, and have very large deflexions; whereas, for heavy weights, as in the case for common commercial scales, weigh-bridges, &c., the springs employed are very strong, and their deflexions will be reduced to a minimum, the multiplication for space indication on the scale remaining considerable and quite sufficiently large. As regards the quality of the steel employed there is such a very small quantity in the whole construction of a weighing machine of the first size (1½ kilogrammes for a machine to weigh 500 kilogrammes) that it will be no benefit to the manufacturer to substitute an inferior steel for that of the best quality, which gives the best guarantee of unchangeability. Before we pass over to the description of the numerous articles of manufacture, to the improving or cultivation of which this discovery may be the origination, we may remark that the weigh-bridge described is almost entirely similar in appearance to a common one, except that in lieu of the common suspension by means of dies and knife edges, there is substituted the system of spring couples, which perform strictly the same functions, the other parts remaining unaltered, including the vertical stem which ties the levers to what is properly called the steelyard. Although there is no change in the exterior appearance, this substitution of spring couples instead of the knife edges will have effected an immense improvement, for we have secured the exclusion of any derangements in work, and of all wear and tear, of any cost of maintenance, since there are no delicate edges to become crushed, broken, or simply worn out, as these do so continually, especially in the very large-sized weighing machines, where the surface cannot be in proportion to the enormous load which they have to carry. This transformation alone has considerable value; but if we complete it by the self-acting spring indicator, which abolishes the use of or shifting and counting of counterpoises, as by the usual steelyard, the consequences of the system will be of much greater importance still, for thus we secure economy in material and in the management or in the rapidity of weighing. Exactness of the weighing is also guaranteed by the continued control given by the index returning to zero after each operation. Whilever this is observed, the apparatus may with assurance be deemed correct.

M. Taurines applies to all his dynamometric instruments the transverse deflexion of curved springs, and in the weighing instruments he has had recourse to another element appertaining to the deformation of springs which never had been taken into consideration before, that is, the rapid expansion of the angle of the tangents drawn from the ends of a deformed or increasingly curved spring; this he calls the "angular flexure." One of these tangents is essentially movable, and is the transferring or marking element in the system, the other end of the spring being *encastré*. After this explanation, it will be seen that if sufficiently lengthened, the extremity of such a tangent would be, for a very small angular flexure, considerably displaced, and that will be the same with all the other like pieces united into one system with this first tangent or spring.

The figure (1) shows a vertical mid-section of an elastic or spring-couple weighing machine. The table of the weighing machine rests upon four stays, of which two are visible, M, *m*. The bar, X X, ties together the two points, C, *c*, and makes them move in a vertical line; on account of the equality of the two double opposite couples, two others such are not visible, being in front of the section. Each of these levers, P A B C, *p a b c*, is separated into two opposite and parallel segments, carried forward to the ends of the table, nearly below the points of support, M, *m*, and tied together by transoms perfectly rigid, as seen in section in the figure. The rigid pieces, A B, *a b* (fig. 1), are realized through the strong parts, S, A H G B, *a h g b*, forming one whole with the transoms. The lever, *b o*, of the couple, *p a b c*, is adjusted to the transom, *a* (fig. 2), but without thereby changing its action, and is tied to the lever, B *o* (fig. 2), by an elastic plate, *o o'*, sufficiently thin to form an elastic articulation, the reaction of which is added to that of the elastic couples; this is, at the same time, the regulating spring of the whole system. The lever, O, is lengthened as far as Z, and there it is connected with a vertical stem by two elastic and very thin plates, *r r*, at right angles one to the other, producing the effect of a universal joint, but without friction (we need scarcely observe, indeed, that there is no friction in any part of the apparatus). This stem carries on the top a small rack working into a brass pinion of fine pitch, on the axle of which is carried a long needle or hand, moving on a dial plate formed of a whole circumference, on which are marked the weights corresponding to the different deflexions of the levers; so that it is sufficient to put the article which is to be weighed on the table, and the needle will mark immediately its weight on the dial plate. This method secures a guarantee for the interested parties, whether purchaser or seller, for both observe together, marked in common plain figures, pointed to by a trusty, passive, and disinterested medium, whose indications are *instantaneous*, which shows its own control immediately and continually, and which cannot easily be tampered with. A mistake is here an absolute impossibility; whereas, in the usual way of weighing, the management of the counterpoises and that of the slider of the common weigh-bridge is not only a ground for involuntary mistakes, but also gives the means to avoid control almost completely, and renders fraud easy; and in the best cases the majority of counterpoises become false, in consequence of wear and tear, or the loss of the lead which adjusts them.

The small but infinitely diffused and multiplied transactions of ordinary social life in the buying and selling of food, &c., constitute the great preponderance of those in which M. de Taurines has very forcibly pointed out how great are the temptations to fraudulent weighing upon the one side, and how impossible it is with even the most rigid state or police control over the weighing instruments and weights to prevent that. He has well pictured the haste with which such weighings are conducted always, and purposely so by the fraudulent dealer, by which it becomes impossible for the timid or the stupid buyer to remark with any certainty whether a just equilibrium has been accorded him or not; that in any case the correctness of the weights must be taken for granted by the buyer; and that no police control can secure against false weights and false balances, in which our London police records quite confirm those of Paris and other cities. It was but a few months since that in London the same person had three sets of fraudulent weights detected with him, and in use within a few weeks. Even where the balances and weights are correct, a stupid or illiterate buyer is often unable to tot up mentally the sum total of the several counterpoises put in a scale to make up a total for which he has to pay, and often such a person does not even know by sight what is the value in weight of each such counterpoise. In fact, there can be no doubt but that the mass of the purchasers of food, fuel, and most other articles of domestic use sold by weight, and especially the poor, who can afford it the least, are almost completely in the power of the seller if fraudulently disposed. Anything that could afford a more effectual check to and check upon this, which in our great English towns, at least, has grown to the magnitude of a nefarious system, ought to be hailed as a positive blessing; for it would not alone tend to make the wages of the poorer classes go as far as they ought, but it would stop up the channels of a flood of moral evil which cannot but have the most debasing effect upon the consciences and self-respect of multitudes of the middle classes. M. de Taurines has represented to the municipal government of Paris, and we think with a great deal of truth, that the substitution of these spring balances of his, by legal enactment, in lieu of all others, would powerfully tend to reduce the amount of fraud such as this; and we quite agree with him that instruments for weighing which shall be incapable of being tampered with except by a very skilful workman, which involve no actual counterpoises, and whose indications should be prompt, exact, and above all, palpable and clear to the eye, could not fail to work a vast improvement upon the present system, or rather no system. To some forms of fraud, but too well known amongst butchers, greengrocers, &c., of course these De Taurines balances are just as amenable as the common scales. The same piece of lead which the butcher nails to the under side of the scale bottom into which he always takes care to put his customers' meat, and which at every draught gives a fraud of perhaps a quarter of a pound in his favour, might be fastened on below and to the platform of a De Taurines weigh-bridge; but it is not difficult to see that the construction might be by law so regulated that the existence of such a *remora* as this without easy observation and detection should be impossible. Frequent and rigid police inspection must always be relied upon in addition as the only ultimate protection; but we believe these balances would powerfully support the efforts of the police, and greatly help the purchaser in their absence.

Another application made of this general principle by M. de Taurines has been to the construction of dynamometers for the continuous measurement and registration of the power exerted by motors. These have, after due tests as to their accuracy, been largely employed, we are informed, on board the steam-ships of the French fleet, for the purpose of recording the work done, and the useful effect in relation to consumption of fuel, &c., of marine engines. These have been dynamically measured by this instrument up to 2000 actual horse-power; and being self-registering instruments, a record of engine performage goes to head-quarters in the shape of curves which defy misrepresentation as to facts. The adaptation of the principle in this case is simple enough, though the details of parts are incapable of being described unless with the aid of complete drawings of the dynamometers. A train of machinery marks the speed of the motor upon a ruled paper wound off from a cylinder. A pair of springs are so connected with each other, and with two coaxial shafts, one being within the other, that they are always flexed by a force precisely equivalent to that of the resistance overcome; but this also must be marked. As the flexure alters, the interior shaft moves a cone more or less in the direction of its own length; from the periphery of this cone always revolving at the angular rate of the motor, motion is conveyed to the force-marking point, which thus varies *its* trace upon the ruled paper in accordance with that force. In this way force and velocity, which together make up energy or work, are both recorded and registered in kilogrammetres, of which 75 go to the actual horse-power.

In its final relations, of course, there are corresponding parts here and in the common Watt indicator, and in the totalizing indicators of Poncelet and of Moseley. In the first the flexure of a spring gives the pressure or force, and the motion of flexion the velocity or range of motion in reference to time, which is the same. But no constantly acting and registering Watt indicator of a satisfactory character has ever been produced to our knowledge, and the totalizing dynamometers were tried with both skill and patience several years ago upon large engines at Manchester without much good result. In fact, they neither would register correctly nor keep in order. The main or important difference upon which the better success of these instruments of M. de Taurines rests consists in the peculiar application of *his* spring, his *ressort accouplé*, by which, with an enormously strong spring capable, if need be, of bearing tons of pressure, and with an extremely small range of actual flexure, that range is sufficiently multiplied, and without any friction of intermediate parts, as to admit of easy registration of the amount of the flexing force, assumed to be in accordance with the Hooke law of elasticity, *Ut tensio sic vis.*—Ed.

A GLANCE AT THE PRESENT STATE OF SOME BRANCHES OF METALLURGIC PRACTICE IN GREAT BRITAIN.

The long continuance of depression in the iron trade of this country is certainly cause enough for us to look rather closely at some of the influences which have been at work to bring about the unhappy state of things which we see around us, and more especially in the once (and that not long since) very flourishing business of the Scotch ironmasters.

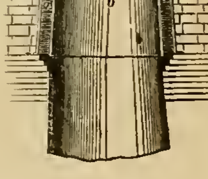
Equally as important as the possession of the materials from which iron is made, is the reduction to a minimum the cost of fuel by which these ores are reduced to the metallic state. For many years past it has been the practice in Continental ironworks to take off what are called the "waste gases" from blast furnaces, and employ them for heating the boilers which drive the blowing engines, and heating the blast. This was practised at Wasseralfingen, in Wurtemburg, as long ago as 1832;* and perhaps in no other case have we a more striking example of the slowness of British manufacturing enterprise to avail itself of the means so obvious for effecting an enormous economy. At last, in a certain district in the North of England, a healthy state of matters has shown itself. The Cleveland ironmasters are not only setting a most telling example to their competitors at home, but the most refined practice in the world is conducted in that locality. To a person unacquainted with blast-furnace practice, beyond being merely accustomed to see tons of useful fuel flung away into the atmosphere as so much blaze of burnt gas, the furnaces in Cleveland would appear not to be in operation, as there the gas is now all utilized—with what effects we shall subsequently show. In Scotland, a partial taking off of the gas was some years ago introduced at the Coltness Ironworks, for the purpose of calcining a clayband ore which is used there. This, however, is only a very partial employment of its useful properties.

As a rule, in this country we find the habit of producers is to take a broad expansive aspect of a manufacture, and from that way of treating it, their appreciation of details is not nearly so complete as in the cases of most Continental manufacturers. From this view they work, and without troubling themselves very much whether, in their practice, they are following the most exact applications of principles, they have long remained content in making, by such and such a mode of treatment, as much profit as they could, and there they have rested.

Fortunately for the iron manufacturers of Great Britain, it generally happens that the fuel is raised in combination with, or in close proximity to, the ores; so that frequently one set of mines, and their accompaniments of men and raising gear, is sufficient. On this very account our ironmasters have been able to make large profits, troubling themselves no further; but all the while other nations have advanced, and, in respect of iron metallurgy, we to a great extent have stood too still—the effects of which we are now beginning to feel in many instances rather acutely.

It certainly is a good old proverb to "let well alone," but we must

Fig. 1.



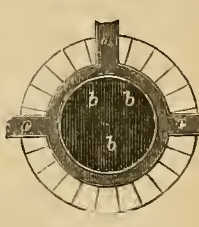


Fig. 2.

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* At page 469, "Metallurgy, Iron and Steel," by Dr. Percy, he translates the following from "Der Flammenofenbetrieb mit brennbaren Gasen zu Veckerhagen," von Hütteninspector C. Pfort, 1842; being an account of an arrangement of a furnace working with charcoal as the fuel, at Veckerhagen. It is represented in the accompanying wood engravings. Fig. 1 is a vertical section of the mouth and throat of the furnace, through the centre; and fig. 2 a horizontal section. Two cylinders of cast iron, *a* and *b*, each 5 feet high and 1 inch thick, but of which one is 1 foot wider than the other, form the mouth. The inner cylinder, *b*, is a prolongation upwards of the shaft of the furnace, and between the outside of it and the inside of the outer cylinder is an annular space 6 inches broad, from which the gas passes through the passages, *c*, *d*, *e*, provided with dampers, so that it may be sent through any one or more at will. From *c*, the gas was used to heat the blast; from *d*, to raise steam for an engine of six-horse power; and from *e*, to carbonize wood in kilns. At Ebbw Vale the gas has been taken off in a similar manner, except that only a single cylinder, 7 feet 9 inches in diameter, and 7 feet 9 inches high, was inserted in the mouth, the gas being withdrawn from the space between the outside of it and the adjacent lining of the furnace.

not forget the degree to which we may trust it. Unfortunately, too many of us are apt to rest our oars heavily on the assurance it brings. In no case has its real value been more strictly exemplified than in that of the British iron manufacturer—who, now that our neighbours are doing for themselves all and even more than they formerly relied on Great Britain to do for them, feels that the race he now has to run is with men of far higher trained intellects, and who conduct their manufacturing processes in a far more exact and truthful way than has yet obtained, except in the Cleveland district, in very few instances connected with iron manufacture at home. Without having attended to all the points of detail in a manner most accurate—without having sought after, and thereby discovered, means for economizing every item of cost—it had been now, as it was but a few years ago, impossible for the Continental iron manufacturer to compete successfully with the British. But what do we find? That in countries where the fuel has to be brought for miles to the furnaces (these being usually placed near the sources of ores) where both fuel as well as the materials are raised from the earth, often at enormous depths, and therefore at an expenditure far higher than anything we witness at home—still, with all these disadvantages, our neighbours are now able to receive, and, it is well known, do receive, orders from this country, and execute them 5 per cent. to 20 per cent. cheaper than they can be met at home. We do not, of course, mean to say that this capacity of cheaper production is entirely due to the attention paid in every detail of manufacture, by reducing each to its cheapest degree consistent with the highest quality of material and workmanship—for the lower price paid for labour, and other causes which we need not enter into now, tend to effect an ultimate economy. And whilst we are fully aware that there are at the present time numerous men, some of them certainly to be considered able judges, who have and still are deprecating our present manufacturing condition to an undue degree, still it is impossible for any one who is in that position, from his own special knowledge, and who is unfettered by trade or party interests, if he be led to consider the present state of nearly every part of the European iron manufacture, and compare with it the present state of the British—all the better if he be able to form a fair opinion from previous knowledge of the state of both ten years ago—and, seeing the strides Europe has made in this branch of industry, when compared to Great Britain, to form any other conclusion than that, whereas in that time at home we have made no widespread advance, elsewhere works have been planted in localities a few years ago all wood and dale. All over the Continent, in Russia, as well as Siberia, new works have found their way into existence, which now stand up as such mighty opponents to us in that quiet security we formerly enjoyed. Therefore, we are alarmed, and surely not without reason; for it is not possible to foresee how the state of our iron manufacture generally is ever to be so lucrative as it once was. We particularly desire it to be understood that these remarks are confined to the producers of the raw material, for there can be no doubt left in the mind of a competent judge, who has had the opportunity of comparing the work of Continental nations in converting the material into structural uses, such as the manufacture of engines and machinery, that in general design they are frequently inferior to the best types produced in Great Britain. At home we may certainly take credit for surpassing the rest of the world in excellence of design for motive machinery—for adapting each part so as best to fulfil its special function, and that, of course, generally means the most economical, and therefore advantageous, disposition of material: in other words, our ideas as to proportion appear generally carried out in a much more perfect way than elsewhere. The proportions and forms of parts of some machinery made on the Continent and in America are occasionally open to great objection; and sometimes, where we find a real excellence of design in a mechanical construction, whether it be a marine or locomotive engine, or a machine tool, we discover that such has been produced under British superintendence abroad, or not unfrequently copied from British models.

Reduction of Ores to the Metallic State.

Under this head there is very little novel that we have not from time to time noticed. Some attempts have been made to effect the direct reduction of the ores by gaseous fuel, among others by Mr. C. W. Siemens. The object has been to supplant the blast furnace; but so far success has not been complete. Indeed, in the present state of our knowledge of the series of changes which it is necessary for the ore to undergo by a properly-ordered succession of actions upon it, it is difficult to foresee how the employment of anything very far different from the blast furnace is to be brought about; for as the materials of the charge gradually descend, they are being as gradually brought under a series of influences by which the metal and its impurities are separated, or the ore reduced, by the time it reaches the lower regions of the furnace. Mr. Siemens has his process under experiment at his own works in Birmingham, from which a small piece of steel was produced and exhibited last year at Paris. It was tried at Barrow, and also at the Atlas Works, Glasgow; but, we understand, so far without success. However, we must not speak for or against this until it is subjected to further proof. Other processes, that of Mr. Henderson, of Glasgow, and one or two for making steel from Cleveland pigs, are said to be ripening into existence; but their being as yet in the experimental stage alone, it is proper at present only to mention them.

Thus, although there is nothing new or marked as yet practically developed in the methods of reduction themselves, there have been some experiments made in this locality of late which point towards the effecting of considerable economy in smelting the richly carbonaceous ironstones.* These have been made by Mr. Henry Aitken, of the Almond Ironworks, Falkirk, and consist in retaining as much as possible of the carbon in the ore by carbonizing or coking it in ovens or closed pits, in place of driving and burning it off in a gaseous form by the old mode of calcining in open air heaps. Now, as all ironstones contain considerable quantities of carbon—some, however, such as the blackbands and ores from the coal measures, in much greater proportions than others—it is evident that if we can retain the carbon or a great portion of it, we need so much less coke or coal for reducing it in the blast furnace. In some experiments with the blackband ironstone, enough carbon has in this way been retained to reduce ore without requiring any further addition of fuel. It is difficult to see any valid reason why this mode of treating the ore is not the very right thing to do. The Almond furnaces are now smelting it with less than half the fuel formerly used.

Blast Furnaces.

In the construction of blast furnaces the chief novelty to note is the enormous increase of dimensions. In the oldest iron districts of this country but few new furnaces have been recently erected; they therefore remain much as they have been for a very long period. The case, however, is different in the more newly developed iron-producing localities of Cleveland, North Lancashire, West Cumberland, and parts of Wales. The present rule is in most cases an increasing height and diameter, although there is reason to fear, as we shall hereafter show, that height in some instances has been carried to too great an extent. We propose to treat of the peculiarities of blast-furnace practice in each of these districts separately. Passing over Staffordshire and what we may call the Midland iron district, wherein there is nothing particular to recount that is not found in a more marked degree elsewhere, we may at once proceed to the Cleveland district.

Cleveland.

In this district the largest furnaces in the world, and most economical modes of working, are to be found. The Acklam furnaces at Middlesborough (fig. 3), built by Mr. Beckton, were three or four years ago the largest ever constructed, being 22½ feet in diameter at the boshes, and 70 feet high from the bottom of the hearth to the top of the brickwork; each are capable of holding 1250 tons of material, and turn out about 350 tons of iron per week. In these furnaces the angle of the boshes is much steeper than it has hitherto been the practice to adopt, being 68° with the horizon; while one of the Ormsby furnaces, belonging to Messrs. Cochrane, has its boshes inclined as much as 75°. In the construction of blast furnaces the proportion of masonry employed, proportionate to the dimensions, has been much reduced. Instead of being constructed entirely of stone and brickwork held together by iron hoops at intervals, the masonry is now frequently built up inside a malleable plate-iron jacket which envelopes it. The direct result of these large furnaces has been the effecting of very great economy. Instead of using 36 cwt. of Durham coke per ton of pig iron produced, that is now reduced to 26 cwt.—in some cases even less; whilst some of these produce 1 ton of pigs with 21 cwt. of coke from an argillaceous ironstone, containing about 31 per cent. of iron. Messrs. Bolckow, Vaughan, & Co., erected two furnaces characteristic by their peculiar proportions of only 16 feet boshes, and 95 feet high. These furnaces have worked well, and there has not been any difficulty in getting the blast to ascend through the materials, neither have the furnaces choked or "gobbed up," as was supposed; and instead of consuming 1 ton of coal per ton of pig iron as formerly, for heating boilers, blast, ovens, and calcining kilns, 10 cwt. suffices. The blast is now heated to a much higher temperature. A few years ago the maximum temperature employed was 500°; this has now crept up to 700°, 800°, 900°, and even 1050° and 1100° Fahr., quite recently, and the probabilities are we shall ere long employ much higher temperatures. A great part of this economy is attributable directly to the use of the blast-furnace gases for firing the boilers and blast ovens, and much, no doubt, to an increased efficiency in management. The materials employed in the Acklam furnaces average about 6 tons to each ton of pig iron produced, the proportions of each being—

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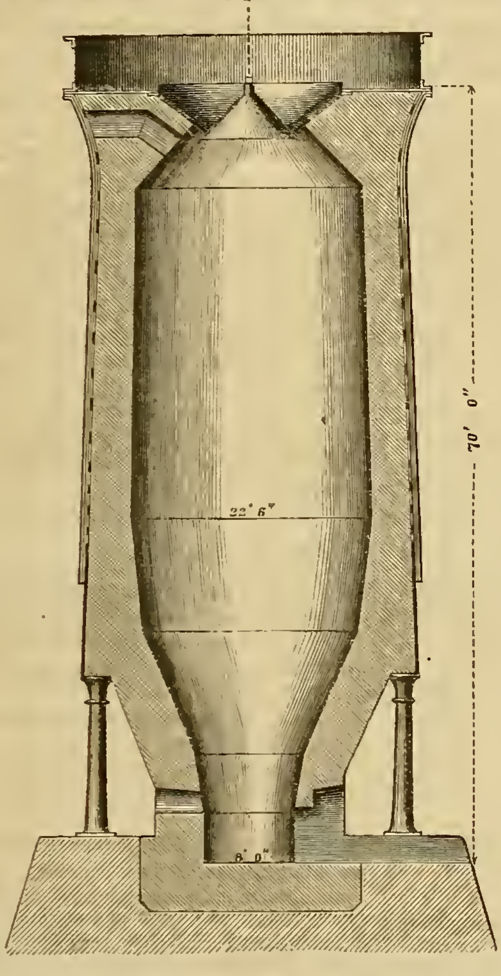
* Vide *Practical Mechanic's Journal*, vol. iii., Third Series, page 362.

Fig. 3.

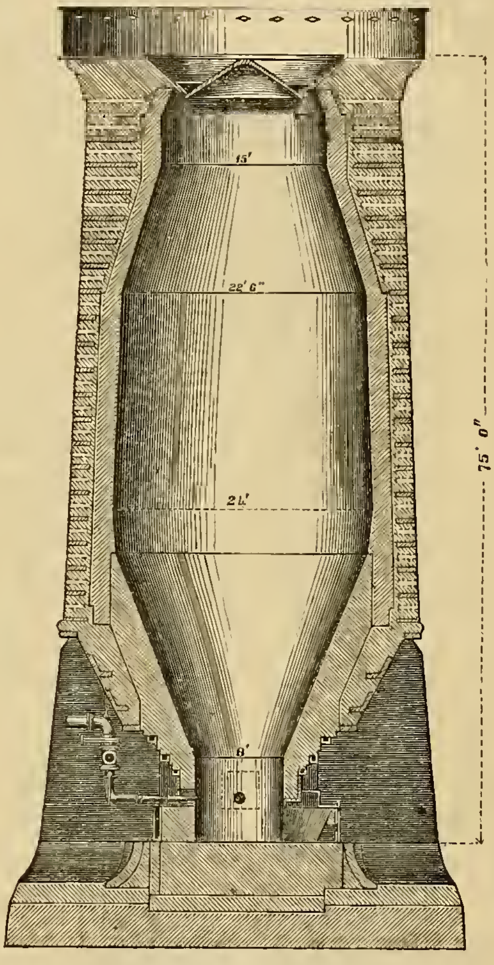


	Tons.
Cleveland ironstone,	3·5
Limestone,	0·75
Coke,	1·30
Coal,	0·50
	6·05

or about 4·25 tons of raw materials, independent of the fuel.

Since the erection of the Acklam as well as the Ormsby furnaces, and through their economical working becoming known, dimensions have still further increased. Indeed, in the Cleveland district capacities per furnace of from 25,000 to 30,000 cubic feet are becoming the rule, the boshes of some furnaces at Stockton being as much as 26 feet in diameter; whilst the Ferryhill and Rosedale Co. have erected a pair 27 feet in diameter, with a height as much as 102 feet. Unquestionably the ironmasters of this district have set a good example to those in Wales, Staffordshire, and Scotland; and the economy they have effected, by paying attention to true principles in construction and practice, has been seriously felt in Glasgow by the great stagnation in the demand for Scotch iron, owing to the lower price at which the Cleveland masters are able and willing to supply the market, whilst they, too, labour under the disadvantage of possessing an inferior ore to deal with. Fig. 4 represents a vertical section of one of the Tees-side furnaces. As soon as the contemplated means for diminishing the cost of carriage of iron from this district to the South is carried out, there can be no doubt but that, in other districts, it will be compulsory to alter the furnaces and mode of working them, to meet the increasing competition that will then present itself. As it is, so much economy is found to depend on the mere size of the furnace, that the older furnaces in the Cleveland district itself are no sooner blown out than they are enlarged, to enable the earlier to compete successfully with the more recent practice.

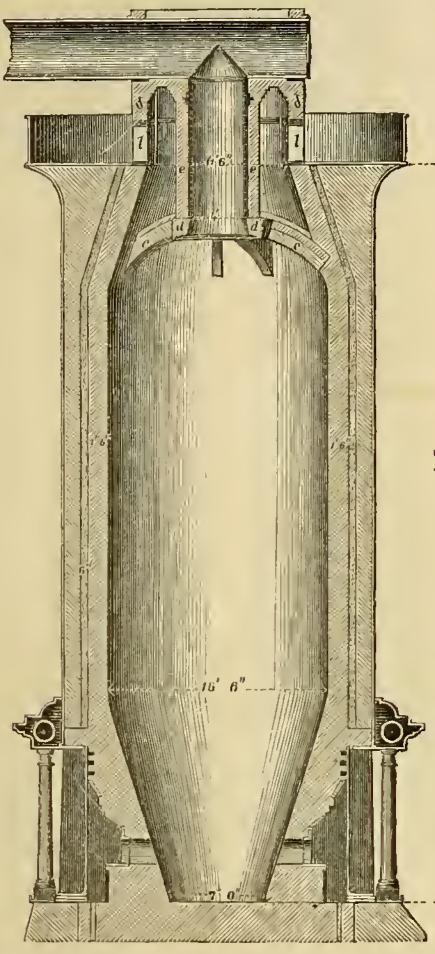
Fig. 4.



In considering the present state of this particular division of our subject, we should leave it incomplete did we not attempt to show some, at least, of the causes why increase of dimensions is found so conducive to economical working. Directly, it is due to the great power of burthen of the coke of the district, generally known as Durham coke. Its resistance to compression was determined a few years ago by Mr. Bell, of the Clarence Ironworks, and he found that a 2-inch cube carried, while cold, a weight of 25 cwt., and when hot, 1 ton, before crushing. The ironstone is not broken up into small lumps, as elsewhere, but charged in large blocks; so that, combined with the great supporting power of the coke, the use of the ironstone in this form enables a very high column of materials to be supported, whilst the space between the lumps of stone is larger, and the choking of the furnace by the weight of the charge is thus prevented, giving at the same time plenty of freedom for the passage upwards of the blast and gases evolved from the lower regions of the charge. With the great height employed, the maximum quantity of the heat which it is possible to so utilize is taken up by the charge, and therefore the temperature of the escaping gases is lower than in furnaces of a less height. These considerations point out distinctly that it would be mere waste of fuel to use a higher temperature in furnaces of less height, because the temperature of the escaping gases would be necessarily higher; and thus we see that the economical upper limit of temperature which it is possible to use is strictly dependent upon that which governs the height of the furnace—viz., the burthen which the materials in the furnace are capable of carrying: so that the more we increase the height of our furnaces, in the same ratio may we increase the temperature and pressure or column of the blast—the latter to enable it sufficient ease of ascent through the increased depth of charge.

It is very important to our iron industry to know the compressive resistance of the various kinds of coke employed in blast furnaces; and since it is evident how largely the exact knowledge and utmost utilization of this particular is likely to affect our pig-iron manufacturers, it is to be hoped that they will not be slow to institute a set of experiments to determine it. We are not aware of the existence of any series of reliable experiments on this point; but judging from the most recent practice in Wales, at the Cwm Celyn Ironworks, where a furnace of enormous capacity has been erected, the resistance to crushing of the coal or coke there employed must be far below that of the Durham coke. It is to increase of diameter also that economy is due; for if we double that, we increase the capacity fourfold, and yet only double the radiating surface. There can hardly be a doubt left in the mind of any one who is capable of forming a fair estimate, but that all furnaces, even in Scotland, where we have to contend with the difficulty of a soft coal, which, *per se*, will not make coke, that the furnaces might nevertheless be enlarged with immense advantage. Such practice, following as closely upon that of the Cleveland ironmasters as the nature of the materials will admit, would save immensely in the Staffordshire, Welsh, and Scotch districts.

Fig. 5.



Barrow-in-Furness.

At Barrow-in-Furness the furnaces are arranged in groups of six, two of which groups are now complete, those last built being the larger. The geographical position of these works, which are close upon the seashore, constituting one feature of the natural facilities the company possess for exporting the produce, together with the command of boundless capital, as well as the scientific treatment by which the manufacture is governed, place these works in one of the most commanding positions in the world. The blast furnaces are not so large as those in the Cleveland district, the largest being 56 feet high and 16 feet maximum inner diameter. The tapping takes place every six hours, giving about 20 tons at each "run out." One ton of coke is used per ton of iron produced—this being remarkably low when compared with the consumption in some other districts; but, of course, much of this economy depends upon the rich quality of the hæmatite ore smelted, which contains from 55 to 60 per cent. of iron; but as the silicon is also present in large percentage, as much as 30 per cent. of lime is required to flux it.

The charge per ton of iron produced runs thus:—

	Cwt.
Raw ironstone, ...	34
Coke from Darlington, from	19 to 21
Limestone, ...	6·5 to 7

At these furnaces part only of the "waste gases" are taken off—and this is effected on a plan introduced by Mr. J. T. Smith, a manager. Each furnace has six openings at the crown, separated from each other by brickwork. These form a ring at the centre, which constitutes the support for a vertical gas tube of brick. The openings serve for charging the furnace through, and as the materials are maintained at a level considerably above the crown, the greater portion of the gases pass off by the central tube. Those portions of the gas which do escape, are burnt in a flame at the furnace top.* Each furnace has six tuyeres, from 2·5 to 3·5 inches diameter; the blast pressure from 3 to 3·5 lbs. per square inch; and is heated from 600° to 650° Fahrenheit.

In charging these furnaces, it is the practice to throw in the materials through five of the openings in succession, and not to charge through the sixth, the object being to produce a somewhat spiral layer of loose materials next the sides of the furnace; and it is found that the sides are thus maintained in better condition, whilst any irregularity in the gathering of the materials in any one place is prevented. After one charging round is completed, except through the last opening, the same operation is repeated, care being taken to commence each rotation through the next opening in front of that through which the last preceding rotation had been commenced.

Through pressure on our space of other matter we must leave the continuation of this important subject until next month, when we hope to consider some of the Scotch and Welsh blast-furnace practice.—V. D.

THE NEW BLAST ENGINES AT CREUSOT IRONWORKS.

(*Illustrated by Plate* 2.)

The Creusot Works employ really seven blowing engines—namely three ancient horizontal engines and four new vertical ones. The actual types are relatively new; we find in works on metallurgy (such as Gruner and Lan, Petitgand and Ronna, &c.) the results of experiments made at Creusot for comparing the useful effect of beam blowing engines, with vertical cylinders and clack valves, with that of horizontal engines with slide valves. There have been formerly at Creusot, engines with slide valves which gave little satisfaction, and which there produced the condemnation of that system; but in order to ascertain whether this condemnation should generally affect the choice of a blast engine, it ought to be known whether the engines with slide valves at

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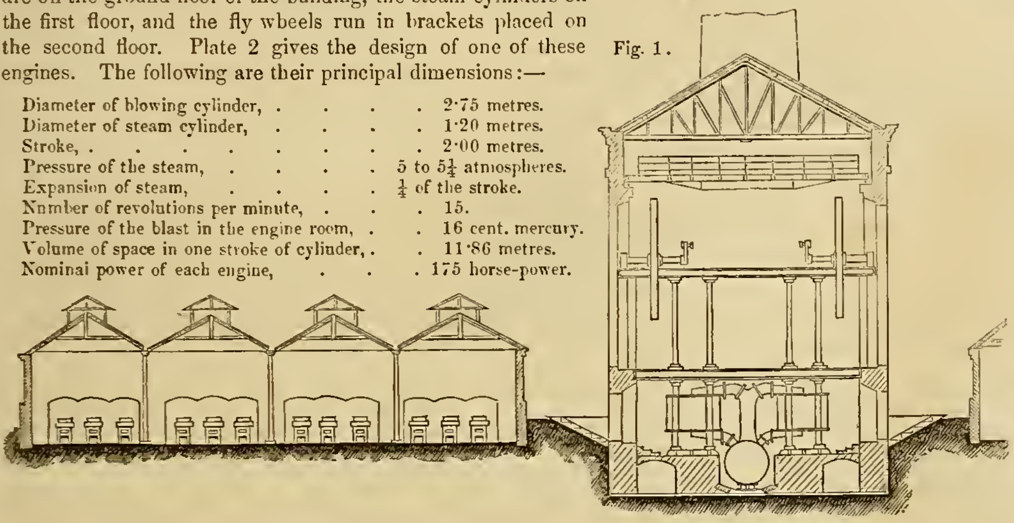
* The furnace has a dome at its top formed of six arches of firebricks, *a*, fig. 5, which unite at the crown in a ring of 4 feet internal diameter, *b*, and thereby form the basis for the vertical gas tube erected upon the top of the ring, *c*, and resting upon the skeleton dome formed by the brick arches. The vertical brick cylinder which forms the gas tube is surrounded by an outer cylinder, *d*, constructed of firebricks, and resting upon the inner brickwork of the furnace itself. This is 11 feet 6 inches internal diameter, and has six side openings, *m*, opposite to the holes formed between the six arches of the dome. These side openings serve as filling holes for charging the furnace, and the materials are kept at a level considerably above the crown of the dome, so that the greater portion of the gases is drawn off through the central tube, and only the remainder makes its escape up through the filling holes and between the two vertical cylinders.

Mr. J. T. Smith has also applied another arrangement, dispensing with the internal vertical tube, and carrying the gases off sideways instead of taking them to the top of the outer cylinder first. In both forms the arrangement has given satisfaction on account of its certainty, and its permanent action without the necessity for frequent repairs.

Creusot belonged to a good type, and whether they had been constructed with that care which we find in different engines employed elsewhere upon the same system. We have some reason to think otherwise, and hence cannot accept the results of the experiments at Creusot as a final condemnation of the system with slide valves. At Creusot they have also given up beam engines with clack valves. Their three horizontal engines have clack valves, and move with sufficient velocity; they are of 50 horse-power each. The newer vertical engines, of which four together are placed in a building, of which we give some idea by the illustrations, figs. 1 and 2, present an architectural imposing front, as all discerned who saw the fine coloured plates which figured in the Exhibition of the Creusot Works at Paris last year. The four blowing cylinders are on the ground floor of the building, the steam cylinders on the first floor, and the fly wheels run in brackets placed on the second floor. Plate 2 gives the design of one of these engines. The following are their principal dimensions:—

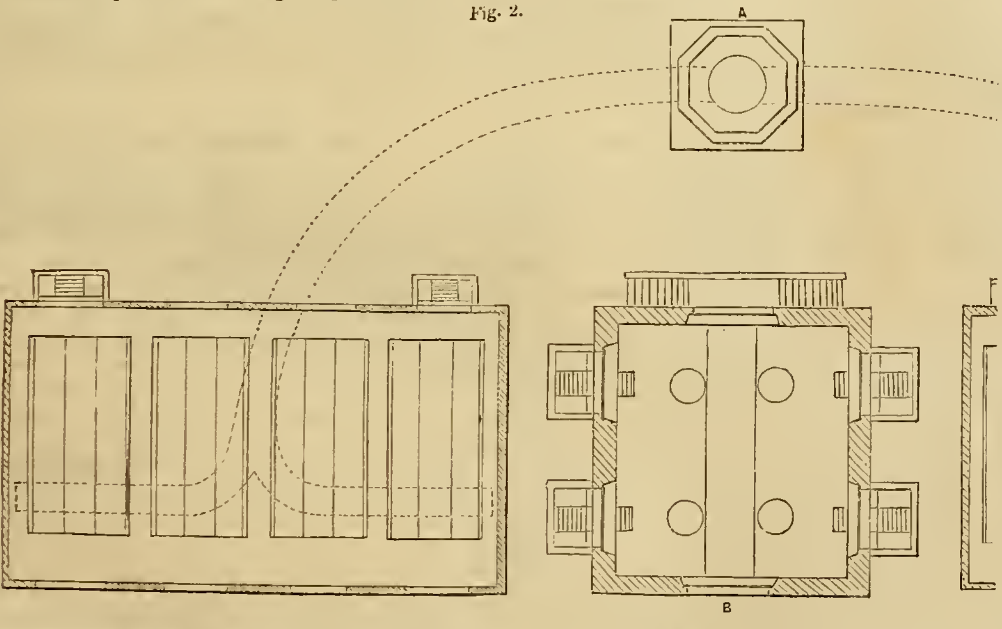
Diameter of blowing cylinder, ...	2·75 metres.
Diameter of steam cylinder, ...	1·20 metres.
Stroke, ...	2·00 metres.
Pressure of the steam, ...	5 to 5¼ atmospheres.
Expansion of steam, ...	¼ of the stroke.
Number of revolutions per minute, . . .	15.
Pressure of the blast in the engine room, . .	16 cent. mercury.
Volume of space in one stroke of cylinder, . .	11·86 metres.
Nominal power of each engine, . . .	175 horse-power.

Fig. 1.



The four engines, having the significant names of *Simoom*, *Mistral*, *Ouragan*, and *Sirocco*, are stated to be unexceptionable in workmanship. The steam cylinders are supplied by an arrangement of four equilibrated valves effecting the expansion, but work without condensation. The blowing cylinders have numerous small clack valves, adjusted to at bottoms perforated like a grating, so that the injurious dead spaces are also as small as possible at each end of the stroke. The frame carries a revolution counter, with a clock, which only goes when the engines are running. The fly-wheel has a balance weight, equilibrating the weight of the piston and rod. The produce in blast is 0·90 of the volume described by the piston. The arrangement of the frame of the iron galleries and staircases, which lead to different stories of the engines, is elegant and carefully considered. Unfortunately these engines, however, present to us faults in the principle of their design. The arrangement of the steam cylinder above the blowing cylinder, and of the fly-wheel above that, which is $13^{m}\cdot50$ above the bedplate, is unstable. This immense height, and the heavy mass of the fly-wheel (40,000 kilogrammes), cannot but produce a serious tendency to rock at high velocities, and, in fact, we understand the velocity cannot be taken without danger higher than as stated—fifteen revolutions per minute, or a velocity of 0^{m} 50 per second—without risk. There is thus lost that rapid beat which is one of the principal advantages of blast engines with direct action. These four Creusot engines, while running fifteen revolutions, are sufficient to supply twelve blast furnaces, which each receive per minute 100 cubic metres of air, calculated at 0° Cent., and $0^{m}\cdot76$ barometric pressure. For the completed design of the works there are projected still two other similar engines, which, when erected at the end of the range, will supply the new projected blast furnaces, and also six cupolas. The blowing engines supply a regulator of boiler-plate iron, about 27 metres in length and 3 metres in diameter, which supplies by means of two main pipes and branch pipes the blast necessary for the blast furnaces after passing it through hot-blast or heating apparatus. The general transverse section of the engine-house, &c., is shown in fig. 3. The steam required for driving the blast engines is generated in twenty-four boilers, erected in two buildings, which are placed at certain positions in the blast-engine range of buildings, as shown in plan fig. 2. These boilers are cylindrical, each of about $1^{m}\cdot15$ diameter, and $12^{m}\cdot00$ length, with a tube of $0^{m}\cdot80$ diameter, and $11^{m}\cdot50$ length. Their total heating surface is 1152 square metres, which corresponds (taking, as is the rule at Creusot, 1⅓ square metre of surface for each horse-power) to a power of 864 horses, or 36 horse-power for each boiler. These boilers are arranged in groups of three, and are heated by the waste gases of the blast furnaces, which are passed into the fireplace or furnace below the grate. They pass at first in a single flue under the main body or exterior of the boiler; then, after arriving at the end nearest to the fireplace, they descend into a second flue surrounding the tube, after having been mixed with air, which has been heated in a long thin-walled flue made in the thickness of the masonry. The used gases escape by underneath flues at the furnace end, and so pass into a chimney common to the twenty-four boilers. This stalk is a real monument; it is conical in form, having a height of 80 metres, and a diameter of $3^{m}\cdot10$, at the top. One group of three boilers is always out of work, and ready to meet accidents, repairs, and cleanings, twenty-one boilers being sufficient for the regular work of the four blast engines.

Fig. 2.

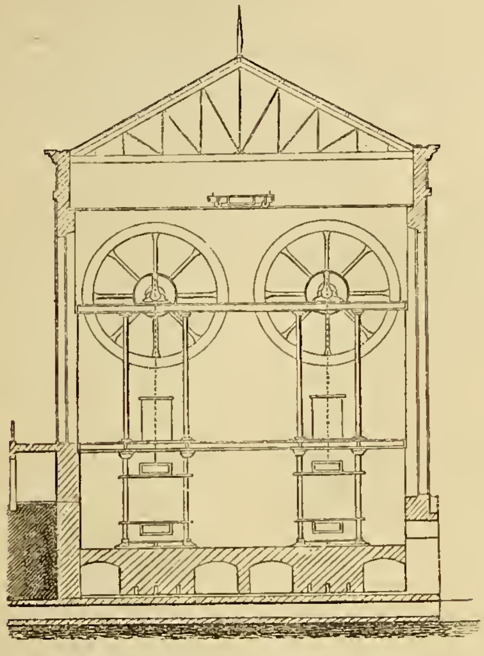


The gases of the blast furnaces pass from each furnace mouth into a great pipe collector, which has a diameter of two metres, and is extended on the entire length of the cornice of the rear wall; this pipe is provided with safety valves and dust cases and covers with hydraulic closures. Explosions of gas are frequent enough in consequence of the number of furnaces, and the best precautions are taken to make them less dangerous, or likely to prove destructive. The pipes, which provide the gas for the steam boilers, as well as for the hot-air apparatus, are branches from this grand-pipe collector. These gases are sufficient for all the blast engines, and also serve to produce steam for the engines for different other purposes, without any appreciable consumption of coal on the grates, with which each is provided in case of need of solid fuel.

The hot-air apparatus used at Creusot are now all upon the English system of curved and divided tubes, called by the French (*à pistolets*), in allusion to their form. There are twenty-four of these, that is to say, 1½ per furnace; and as each apparatus has about 125 square metres of heating surface, it follows that there are about 180 square metres of heating surface per furnace with three tuyeres, but only 125 metres for some furnaces, which have only two tuyeres. The blast may be heated to 400° Cent., but, on the average, the temperature is not employed much below 340°. The loss of pressure which the blast suffers in passing from the blast engine to the furnace, by passing through this apparatus, is estimated at about one centimetre of the mercury gauge.

They had formerly at Creusot hot-blast apparatus with horizontal pipes leading at the ends into chests, replacing the generally used elbow pipes there; a modification applied by M. Bourdon to a well-known system, commonly called that of Wasseralfingen. In 1863 the two last of these apparatus were removed; which had the inconvenience of heating badly, and of frequent escapes of blast. The managers at Creusot are pleased with the present apparatus, in which the *pistolet* bent pipes, placed vertically, heat the blast much more powerfully, and in which escapes of blast are very seldom experienced, since they are so arranged that expansion does not affect the joints. For really good management this apparatus must always be placed as near as possible to the furnaces, in order that the blast may not get cooled on its passage between the apparatus and the twyers, and those parts of the blast pipes which are in the open air should be jacketed in order to prevent any loss of heat.

Fig. 3.



There is no doubt that these blast engines are a very much superior job in point of design to that exhibited at Paris last year by the Cockerill Company from Seraing, although, as we have not hesitated to say, both are liable more or less to the same objection of great height, the placing of heavy moving parts high up, and making the building support the machine. Vertical blast engines, and those direct acting, are the right thing beyond question, though more expensive than horizontal ones; but the *idea* that should be aimed at, in our judgment, always should be, to place the engine and fly-wheels at the base of the system, to sink these wherever circumstances will allow in a basement story or *souterraine*, and to place the blast-cylinder overhead, and let all its support and lateral steadyments spring from the main framing of the system, and from no points higher than the ground level. Above this, the house should be merely a weather casing for the machine.—Ed.

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RECENT PATENTS.

MANUFACTURE OF METALLIC CASES.

J. S. Henderson & J. Macintosh, *Aberdeen.—Patent dated July 11, 1867.*

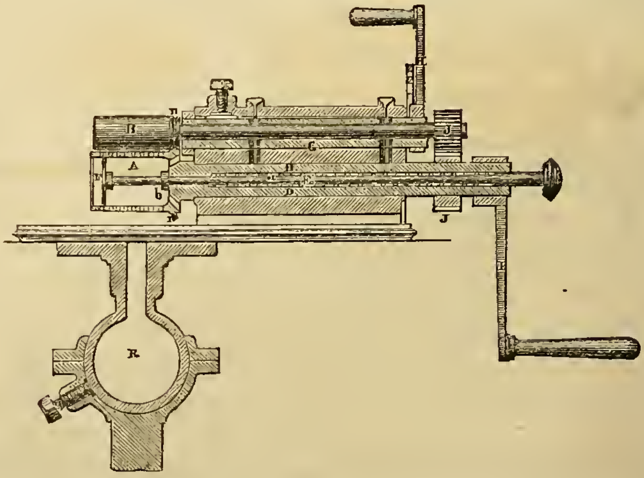
This invention relates essentially to the manufacture of metallic cases, and consists in bending sheets of tinned iron plate or other metal to the required shape on cylinders, and in effectually soldering them whilst on the cylinders. The metallic plates are introduced in succession between two cylinders or rollers, the upper roller being acted upon by a spring or other yielding arrangement, and the under or larger roller, round which the plates pass, has a check or groove upon its surface which forms the necessary seam upon each plate. This lower forming cylinder or roller moves in a suitably formed or hollowed out case, with a clearance for the plates to pass free; and as soon as the plate has the cylindrical form imparted to it, the solder is applied by soldering bolts having an automatic parallel action, or they may be soldered by hand-bolts in the ordinary manner.

These bolts are so formed that their points remain perpendicular in any given arc of their revolution, the solder pot being placed in such contiguous position that on being turned back the bolt dips sufficiently deep to lift the supply necessary for each seam.

It will be observed that the foregoing modification is specially applicable to the manufacture of cases whose seams require soldering, but the machinery is equally applicable to the manufacture of cases with overlapping seams which require no soldering, by simply modifying the form of check on the case-forming cylinder or roller; the plates to be so bent having their ends first bent over before being put into the machine, so as to fit into a groove formed into the binding roller, into which they are compressed during the revolution of the cylinder for the purpose of imparting the cylindrical form.

Fig. 1 of the engravings is a vertical longitudinal section of the machine; fig. 2, a vertical transverse section. In these figs. similar parts are indicated by corresponding letters of reference. This machine is constructed with a *forming roller*, A, in the top of which is situated a pressure or feed roller, B; both of these rollers are carried in the case-frame or headstock, C, and overhang their bearings, so that the metallic cases may be easily removed from the rollers when they are formed. For this purpose the spindle, D, of the lower or *forming* roller, A, is hollow or tubular, into which there is fitted a rod, E; and on the end of this rod, which projects into the interior of the forming roll, A, a metallic disc, F, faced or not with wood, is fixed, and by means of the rod, E, and disc, F, the cases are pushed

Fig. 1.



off the forming roll, A, the disc being returned to the interior of the roll by means of the spiral spring, *a*, the collar, *b*, preventing it going too far. The bearing of the top roller, B, is lined with an excentric tubular bush, G, which is turned by the lever, H, so that the distance between the rollers may be regulated according to the thickness of the metal of which the cases are being made. To provide for inequalities in the thickness of the metal being used, a metallic or india-rubber spring is placed on the top of the excentric bush, G, the required amount of pressure being applied by the set screw, *d*. The rollers are turned by the lever, I, and pinions, J, or by a cord passing round a pulley actuating a tooth-wheel. The lower or forming roller, A, is inclosed in jaws, N, fitted in the slides, *f*, on the sole-plate. The jaws are pressed against the roller by means of a cord passing over the pulley, O; one end of the cord is attached to the bracket, P, and the other end to a weight or treadle. When the pressure is relieved the jaws are pushed open by the spiral springs. The metallic plates are fed into the machine from the table, Q, which is furnished with a ledge, *h*, on each side, one of which is grooved, so that the plates may be prevented from twisting as they are drawn in by the rollers. The machine is supported in a ball and socket joint, provided with a punching screw, fig. 1, so that it can be turned into any convenient position for allowing the roller to run free upon and into the joint. Fig. 4 is a sectional plan; fig. 5, a transverse section on the line, *a–a*, fig. 4. In this arrangement the forming roller, A, is placed uppermost, and the jaws, B, are opened by means of the levers, C, actuated by the springs, D, and drawn together by a cord attached to each lever, C, passing over a pulley, P, on the opposite lever.

Fig. 2.

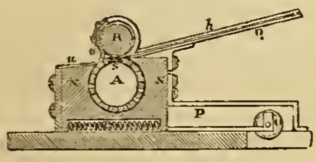
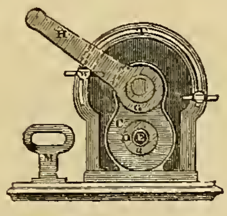


Fig. 3.



The mode of operating with the machine is as follows:—The sheet of metal is placed on the feed table, Q, the end of it being inserted into a groove formed in the steel plate, S, fig. 2, of the forming roller, A; the machine is now turned by the handle, I, or a pulley, and the case is formed in the annular space between the roller, A, and the jaws. N. As the annular space is only sufficient to allow one thickness of metal to pass, as soon as one revolution is performed and the lap of the joint arrives at the point, *r*, the top or pressure roller, B, is relaxed by turning the excentric tube, and the bent plate now being released from pressure springs from the lower roller and against the interior of the case, thus allowing the lap edge of the plate to leave the groove in the steel plate, *s*, as the roller passes a little further round, thus giving a solid part of the roller to the seam to be soldered.

Fig. 4.

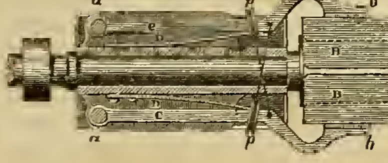
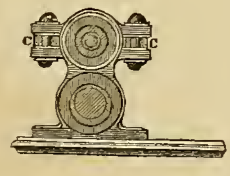


Fig. 5.



The bottom is now put on; and to permit of this being done conveniently, the end of the canister is allowed to project a little beyond the rollers. The side seam is soldered, the edge of the plate being held down by the spring or *ductor*, O, fig. 2, which is screwed to the excentric bearing. The jaws, N, are now released and pushed open by any of the modes hereinbefore described; the top roller is also lifted by the excentric bush, G, turned by the lever, H, figs. 1 and 3. The forming roller, A, is now perfectly free, and can be turned into any convenient position for soldering the bottom; when that is done the canister is pushed off the roller by the disc, F, being pushed out by the rod, E. For some purposes it is preferred to fit the lid or cover of the canister inside, and when so fitted a crease is formed round the mouth of the case by a similar form of groove and projection being given to the neck of the rollers, as shown at *n*, fig. 1.

The jaws are now closed, and the feed roller, B, is brought back to its position by turning back the lever, H, until it comes in contact with the stop or set screw, *w*, which is set in the arc, T, fig. 3, to preserve the same space between the rollers while working with the same thickness of metal. Another sheet of metal is now put in, and the operation proceeds as before. The soldering of the cases may be done in the ordinary manner by hand-bolts.

On fig. 2 the forming cylinder, A, is shown perforated, so that in soldering the heat may not be abstracted too rapidly from the solder, or the roller may be formed of or covered with wood. A steel plate, *u*, is fitted on the top of one of the jaws, as the solder does not adhere so readily to steel.

This apparatus is also applicable for making canisters in which the joints are not soldered, but the edges are made to clasp each other; convenient grooves being formed in the rollers to suit the form of joint.

It is to be understood that in addition to forming cylindrical cases in the manner hereinbefore described, they may be made of other forms, viz., elliptical or polygonal, the forming and pressing rollers in either instance being shaped so as to enable the revolving action necessary for the production of those forms to be effected.

ACTUATING MOTIVE-POWER ENGINES.

Colin Brown, *of Glasgow.—Patent dated 28th June*, 1867.

This invention has for its object the application of atmospheric air, heated whilst under compression, for the purpose of driving motive-power engines, and may be applied to actuate engines constructed generally similar to steam or other motive-power engines, either on the high-pressure or low-pressure systems, or both combined. The air is compressed into a receiver, which may be inclosed in a furnace, or it may be situated in a steam-boiler, or in the receiver a coil or coils of pipes may be placed, and surrounded with steam of high temperature, or through which steam may be passed, thus maintaining the air in the coil, or coils, or receiver, at the requisite temperature and pressure. In the high-pressure engine the motive force obtained is that due to the pressure of the heated and compressed air in the receiver, minus the pressure of the external atmosphere. The admission of the heated compressed air to the cylinder may be regulated by valves worked by expansion gear, and in order to produce a more uniform rotation, two or more engines may be coupled together, in which the degree of expansion is regulated, so that the combined pressure in the cylinders is nearly the same at all times. After the heated compressed air has passed through the cylinders it may be allowed to escape into the atmosphere. In the condensing engine the heated compressed air is condensed in a condenser, or cooled in any convenient manner, and again pumped and compressed into the receiver; thus the same supply of air is repeatedly used without loss other than that unavoidable through leakage.

DECORTICATING CEREALS.

Messrs. Gibson & Walker, *Edinburgh.—Patent dated*
20th September, 1867.

This invention relates to certain apparatus to be used for decorticating cereals. The machine consists of a drum formed of four or more cast-iron sheaves, keyed upon a vertical shaft. A flanch is formed round the edges of the peripheries of the sheaves, and the space between these flanches filled alternately with slips of glass and cement. To facilitate the filling in of the glass several narrow slots are made in one of the flanches of the sheave, which is closed with a slip of malleable iron, and fastened with a nut on the inner side of the periphery. The top end of this drum is covered with a plate of sheet iron. The drum is inclosed in a casing formed of a ribbed framing, cast in quadrants, and bolted together by bolts passing through the flanches. The framing of two of the quadrants is constructed so as to receive the inner frames, which are bolted through the rings of the main framing; these inner frames are filled with glass and cement in the same manner as the periphery of the drum, care being taken that the slips of glass project a little beyond the cement. On the inside of the other two quadrants of the framing iron-wire gauze frames are fastened. The casing is closed at the top and bottom by circular cast-iron ends, with a hopper situated at the top. The action of the machine is as follows:—The cereals to be decorticated are introduced into the hopper, and fall upon the revolving plate which covers the top of the drum. The grain being thrown outwards by centrifugal force falls over the edge of the plate, and the husk is rubbed off as it descends between the glass surfaces of the revolving drum and the casing. As the grain passes down it is guided from sheave to sheave by malleable-iron rings, and the husks are blown out through the meshes or openings of the wire gauze, the decorticated grain passing through the same openings as it reaches the lower side or end of the casing.

REVIEWS OF NEW BOOKS.

A Magyar Mérnök Egyesulet Köslönye, &c. Szerkeszti Szily Kálmán. Parts 1 and 2. July to October, 1867.

Here is a remarkable example of the new life infused into Hungary, since the battle of Sadowa has changed the destinies of that noble country, with those of the Austrian empire, and at last given it that nationality and constitutional government which it so long had in vain longed for, hoped, waited, and bled for. Here is a Magyar quarterly journal of civil and mechanical engineering and architecture, of which two highly respectable parts (the first that have appeared) in small quarto, are before us, published by Enrich Gusztav, at Pesth, and printed in the Hungarian tongue.

The work, which is accompanied by a fasciculus for each part, of large folded lithograph maps, would so far be creditable anywhere in Europe. It is, no doubt, satisfactory and consoling to Magyar nationality and pride that it should appear in the national tongue; but we must warn the editor, Professor Kálmán, and the publishers, that for any general use it is, or is ever in our days likely to be, amongst the engineers of Western Europe, it might just as well have been printed in Zend or Chinese as in Hungarian. How desirable it would be for the real spread of knowledge itself, as well as for that of the mutual knowledge of each other that unites in mutual respect distant races and peoples, that some sort of convention were established throughout Europe, that all the periodicals, memoirs, transactions, &c., of the nations of Scandinavian, Russian, or Teutonic stock should be published in German and printed in Roman characters, and that all those of the Romance nations should be so in French. There would thus be but three languages over the whole earth necessary to be known, in order to come at the scientific and technological lore of all the chief nations of the world. Of what earthly use over the greater part of the civilized world at present are the Transactions, for example, of the Petersburg Academy of Sciences? Formerly these were the oddest sort of polyglot; memoirs were to be found in them in Latin, Russ, German, and French, and perhaps other tongues: but since the grand nationality fever of late years has seized upon Russians, nearly all the papers are in Russ, and illegible to the greater part of the world. Nothing can be more tantalizing than to see, by glancing at the formulæ (in the universal tongue of mathematics) in some important memoir, that it is one of high interest, intended to be given to the world, but through an absurd linguistic whim, in reality withheld. Surely, with all their Pansclavism, educated Russians or Magyars do not imagine that Westphalians, Saxons, Frenchmen, Italians, and Englishmen will, within the next thousand years at least, have come to be rendered erudite in the Sclavonic tongues, at the knout's end or bayonet's point. If not, and that their scientific and technological literature is to be anything more than a literary mirror for mutual admiration with them at home, they had best show their good sense in dropping the nationality, so far as language and type are here concerned. To return to the periodical before us: these parts not alone present evidence of the intellectual life now barming in Hungary, but by the accounts given of some of the vast works projected or in progress in Hungary, prove what a real vitality now stirs in the social state of that by nature grandly endowed country.

Amongst the maps given, is one showing at the end of last year the state of the railway communications of Hungary, the lines open, those in progress or in hand, and those projected. In the completion of this grand network over a country often difficult and broken, there is work enough for local engineers, if not for some of our own at present but ill-employed ability. A country that in one product of its mighty husbandry alone, in that of wine, produces about 65,000,000 or 70,000,000 gallons per annum, can afford rapidly to complete its railway system, even though it suffer, as recently, by occasional great failures of crops and scarcity.

Another map shows one of the grandest and boldest works of arterial drainage that has ever been projected in Europe, viz., a vast canal to drain as well as to form a navigable communication through that prodigious swampy plain, or rather that great aggregation of paludal districts which lie along the Theiss and to the eastward between that river and other more oriental affluents of the Danube. This great arterial drain will be a canal of between 70 and 80 miles in length, running nearly north and south, and in length about equal to the two ancient canals the Franzeus and the Bega united, which join the higher reaches of the Danube with the Theiss, and the latter with Temesvar to the east. The northern end of this great canal will start from a point not very far from the far-famed Tokay.

Ammunition: A Descriptive Treatise on the different Projectiles, Charges, Fuses, Rockets, &c., at present in Use for Land and Sea Service, &c., &c. By Captain Vivian D. Majendie, R.A., Assistant Superintendent Royal Laboratory, Woolwich. 1867. Part I. 1 vol. 8vo., with Plates separately.

This is one of the most creditable volumes which has been produced by any one of the officers of our artillery upon any purely professional subject. Its scope is limited to ammunition and stores for smooth-bore artillery only, so that we may anticipate at some future time another part or volume which shall give, in the same clear, full, and exhaustive style, the history and description of all the much later ammunition contrived for rifled artillery. Of course, the great body of this closely but clearly printed volume addresses itself primarily to professional artillerists, and the mere lazy reader *pour passer le temps*, will scarcely care to be instructed as fully and as minutely as to all the art and mystery of all and sundry the products of the Royal Laboratory at Woolwich as Captain Majendie has deemed fit his readers should be at his hands. But even the most idle *dilettante*, if he have a spark of mental vigour or curiosity left, will find himself interested in the scholarly and able sketches which are given of the rise, progress, history, and successive developments of every form of smooth-bore ammunition, from the old stone shot and the ancient *cominges* to the "great granadoes thunder" and the improved shrapnel.

These chapters of military archæology are throughout supported in every statement by authorities quoted in large and densely packed footnotes; whilst in appendices reaching up to M, various special subjects of wider import have been specially treated, both historically or descriptively and scientifically. Amongst these appendices are several papers of very great scientific interest. In those marked A and B the whole history of a peculiarly British and highly important projectile, the shrapnel, or "spherical case shot," as it was called in the palmy days of Vimiera, where it first did terrible service, is given, and the claims to the invention set up by Germany and by France, we think satisfactorily disposed of.

There are numbers of tables of dimensions, weights, and so forth, which refer to the subject matter of the volume, and add greatly to its professional value. For the volunteer artilleryman who has already mastered the elements of gunnery—for which, by the way, he had best begin by acquiring some rudimentary *exact* notions as to statics and dynamics—and who has got through the text-books that enable him to know one end of a gun from the other or perhaps a trifle more, no work with which we are acquainted in English will be found better professional reading, or from which he may derive more information in a more agreeable manner than from this volume of Captain Majendie's, which, as we remark by the title-page, has been printed by order of the secretary of state for War.

SHORT NOTICES.

Dictionnaire Général des Termes d'Architecture en Français, Allemand, Anglais et Italien. Par D. Ramée, Architect. Reinwald, Paris. 1868.

This dictionary, though professedly confined to architectural terms, is worthy of being noticed, because, within a small compass (it is complete in one not very thick octavo volume of clear, good type and paper, and not dear (it comprises a very good polyglot technical dictionary in the four most important of European tongues. A similar volume dedicated to civil and mechanical engineering would be of much value. In reality, a good polyglot technical dictionary, which takes in the whole range of the constructive arts, does not exist as yet, and those which do exist are cumbered with much useless and often inaccurate information relating to trades and handicrafts of little use to any one, and of none to the engineer, the architect, or the mechanician. In any case, manufactures, trades, handicrafts, and commerce should have technological dictionaries of their own.—Ed.

De l'Etablissement des Puits de Mines dans les Terrains Ebouleux et Aquifères—Fonçage, Consolidation, Reparations, &c. Par G. Glepin, Ingénieur des Mines du Grand Hornu. 1 vol. folio, with Atlas of Plates. Baudry, Paris. 1867.

This work, which is of a thoroughly practical character, gives in a very thorough way precise accounts, with details of procedure, of expenses, &c., of the various methods employed for coal-pit shaft-sinking in wet strata or running sands, and more particularly of the methods employed in sinking through those great marl beds saturated with water which overlie the coal measures of the Pas de Calais, of part of Belgium, and of the northern section of the Westphalian coal fields. These running marls, often extending to a depth of nearly 500 feet, and with a limitless supply of water, present difficulties to the shaft-sinker probably not exceeded in any part of the world; and as these difficulties have been in very numerous cases completely overcome, and by methods as remarkable frequently for their simplicity as for their ingenuity, the perusal or even study of this and other works (for there are many others) on the subject cannot fail to be of great service to our British and colonial pit-sinkers who have to encounter watery beds, though luckily upon a less formidable scale.

For the information of those interested in *Vulcanology* we may mention that two new works of some interest have lately appeared; one upon the geological and topographical features of Teneriffe, before so fully treated of by Von Buch and Piazzi Smyth. This contains a good many sections to natural scale, taken in various directions across the island volcanic mountain, which are not without important bearings to the physical student of vulcanology. The other work is descriptive of the eruption of 1866 of the island volcano of Santorin. The following are the titles of these respective works:—*Tenerife, Geologisch-topographisch Dargesteldt, ein beitrag zur Kentniss Vulkanischer Gebirge. Von K. V. Fritsch, G. Hartung, und W. Reiss.* 1 vol. folio, with Maps and Sections, &c. Wursten & Co., Winterthur. 1867. *Ueber den Vulkan von Santorin und die Eruption von* 1866. *Von Karl von Seebach.* 1 vol. 4to, with Maps and Plates. Dietrich, Göttingen. 1867. The latter work is extracted from the thirteenth volume of the Transactions of the Royal Philosophical Association of Göttingen.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF NAVAL ARCHITECTS.

ON WAVES WHICH TRAVEL ALONG WITH SHIPS.

By W. J. Macquorn Rankine, Esq.

1. *Object of this Paper.*—The relation between the length of a wave and the speed with which it travels in water of unlimited depth, when not interfered with by external forces, is well known; and it was many years ago made use of by Mr. Scott Russell as the basis of his theory as to the least lengths proper for the entrance and the run of a vessel respectively in order that she may be driven at a given speed without causing the resistance to increase faster than the square of the velocity. The object of the present paper is to show how a certain relation between the *depth to which the disturbance of the water extends, and the speed of the wave*, bears upon the form and motion of waves which travel along with ships.

2. *Speed of Wave in an Uniformly Disturbed Canal.*—It has long been established, both by theory and by experiment, that when a wave travels along a canal of a given depth, and when the horizontal component of the disturbance of the particles of water is uniform throughout the whole depth of the canal, the speed of advance of the wave is equal to the velocity acquired by a heavy body in falling through half the depth of the canal: that is to say, in algebraical symbols, let k denote the depth of the canal; g, gravity; and a, the speed of the advance of the wave; then

$$a = \sqrt{g k};$$

the value of g being very nearly 32·2 feet, or 9·81 metres.

3. *Relation between Speed of Wave and Virtual Depth of Uniform Disturbance.*—Very recently it has been proved* that a similar relation exists between speed of advance and depth of disturbance, even in water of unlimited depth, and with a horizontal disturbance following any law whatsoever; provided that for the actual depth of an uniformly disturbed canal there is substituted what may be called the *virtual depth of uniform disturbance;* or, more briefly, the *virtual depth*—that is to say, a depth found in the following manner:—Conceive a stationary vertical plane, of a given breadth, to coincide at a given instant with the crest of a wave, where the motion of the particles of water is wholly horizontal; find the rate, in units of volume per second, at which the water passes through that plane, owing to the disturbance: divide that volume by the horizontal velocity of a surface particle, and by the breadth of the plane; the quotient will be the *virtual depth.* Let this be denoted by k; then the speed of advance of the wave is $a = \sqrt{g k}$, as in the formula of the preceding article.† This principle is quite universal, and holds for waves of all figures, and for every kind of disturbance, provided only that the upper surface of the water is free; and all the values of the speed of advance of waves in terms of length, or periodic time, &c., which have been arrived at in previous researches, can be deduced as particular cases from the value in terms of the virtual depth.

4. *Speed of Advance in Terms of Periodic Time.*—According to previous researches which are well known, the speed of advance of a wave is expressed as follows in terms of the time which a disturbed particle of water occupies in performing one revolution:—Multiply the periodic time in seconds by the radius of a circle whose circumference is equal to the acceleration produced by gravity in one second, and by the ratio which the greatest vertical velocity of the surface particles bears to their greatest horizontal velocity. In symbols, let T be the period in seconds; g, gravity; u_1, the greatest horizontal velocity of a particle; and v_1, its greatest vertical velocity; then the speed of advance is

$$a = \frac{v_1}{u_1} \cdot \frac{g}{2\pi} \cdot \mathrm{T}.$$

The value of $\frac{g}{2\pi}$ is 5·12 feet, or 1·56 metres per second.

The length of the wave is of course $\mathrm{L} = a\,\mathrm{T}$. When the actual depth to which the disturbance of the water extends is great compared with the length of a wave, it is known that the greatest horizontal and vertical velocities of a surface particle are sensibly equal; so that the speed of advance in that case is simply equal to the period in seconds multiplied by the radius of a circle whose circumference is equal to the acceleration produced by gravity in a second; or denoting this last-mentioned speed of advance by b, we have

$$\begin{aligned} b &= \frac{g\,\mathrm{T}}{2\pi} \\ &= \mathrm{T} \times 5{\cdot}12 \text{ feet per second.} \\ &= \mathrm{T} \times 1{\cdot}56 \text{ metres per second.} \end{aligned}$$

5. *Acceleration and Terminal Speed of a Wave.*—When a rolling wave of a given period travels freely, the virtual depth (k) and the ratio of vertical to horizontal disturbance $\left(\frac{v_1}{u_1}\right)$ necessarily adjust themselves so as to make the values of the speed of advance in terms of the virtual depth, and in terms of the period equal to each other. That is to say, in symbols, we must have

$$\sqrt{g k} = a = \frac{v_1}{u_1} \frac{g\,\mathrm{T}}{2\pi} = \frac{v^1}{u^1} b;$$

and consequently,

$$g k = a^2 = \left(\frac{v_1}{u_1}\right)^2 b^2.$$

When the disturbance which originally produces a wave extends to an actual depth which is small as compared with the whole depth of the water, the ratio $\frac{v_1}{u_1}$ of the vertical to the horizontal is less than unity, so that $g k$ is less than b, and the speed of advance is less than that corresponding to the same period in deep water. As the wave advances, the disturbance is gradually communicated downwards to layers of water situated at greater and greater depths below the surface; the surface velocities of disturbance (v_1 and u_1) both diminish, and the horizontal surface velocity, u_1, diminishes the faster of the two, so that the ratio $\frac{v_1}{u_1}$ of the

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* See Proceedings of the Royal Society, 1868.

† In algebraical symbols, let u_1 represent the horizontal velocity of a surface particle; u the horizontal velocity of a particle at the depth, z, below the surface; $d z$, the vertical thickness of the layer of water in which the horizontal velocity of the particles is u; then the *virtual depth* is given by the formula,

$$k = \frac{\int u\,dz}{u_1}.$$

For example, in water of very great depth it is already known that

$$u = u_1 e - \frac{2\pi z}{\mathrm{L}},$$

approximately, where L is the length of the wave; so that in that case we have for the virtual depth,

$$k = \frac{\int u\,dz}{u_1} = \frac{\mathrm{L}}{2\pi}$$

and for the speed of advance

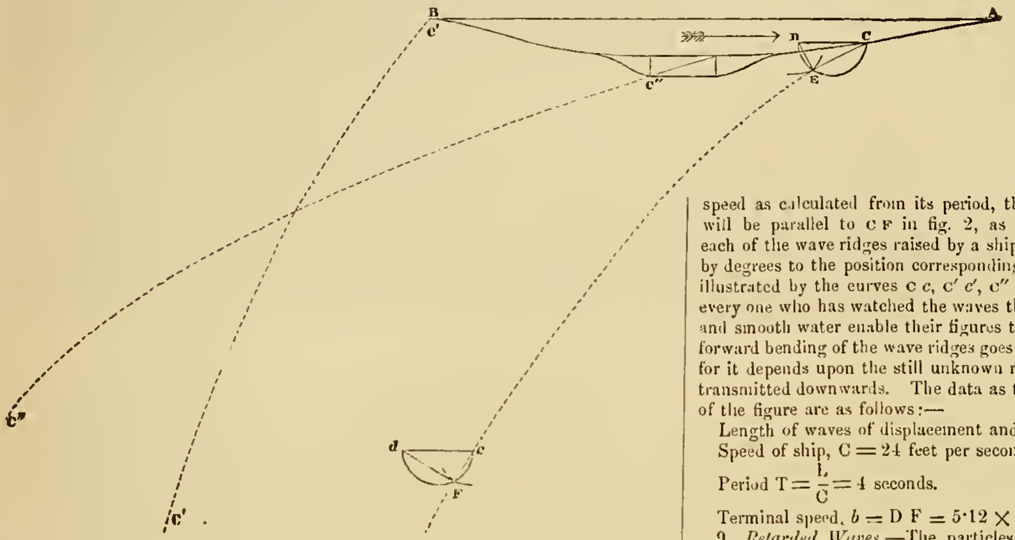
$$a = \sqrt{g k} = \sqrt{\left(\frac{g\,\mathrm{L}}{2\pi}\right)};$$

being the well-known expression for the speed of a rolling wave in deep water in terms of the length, which various authors have deduced from the principle that the free surface of the water is everywhere normal to the resultant of gravity and reaction.

vertical to the horizontal velocity approximates to equality; the virtual depth (k) increases, and approximates gradually to the value $\left(\frac{b^2}{g}\right)$ corresponding to the speed of the wave when the actual depth to which the disturbance extends is unlimited; and the result is, that the wave advances with a speed gradually increasing, and approximating closer and closer to the speed (b) corresponding to the period when the horizontal and vertical disturbances are equal. Hence the speed (b) may be called the terminal speed of advance of a wave of the given period, and the corresponding value of the virtual depth $\left(\frac{b^2}{g}\right)$ may be called the terminal virtual depth. The length of the wave gradually increases proportionally to the speed of advance, and approximates towards a terminal length ($b\,T$)

6. *Oblique Advance of a Wave.*—It is to be observed that the speed of advance referred to in the preceding articles is measured in a direction perpendicular to the ridge or crest of a wave. When the solid body by which a wave is raised moves through the water at a speed greater than the speed of advance of the wave, the ridge of the wave places itself so as to advance obliquely, and the obliquity is determined as follows:—In fig. 2, let C be the point where a wave crest is raised by a solid body moving through the water at a speed greater than the speed of advance corresponding to the virtual depth of uniform horizontal disturbance. Draw D C to represent the velocity of the solid body, and upon it as a diameter describe a semicircle. Then about D, with a radius (D E) representing the speed of advance corresponding to the virtual depth, draw a circular arc cutting the semicircle in E, and draw the straight line, C E; this will represent the position which will be assumed by the wave ridge, so as to enable it to travel along with the solid body.

Fig. 1.



7. *Application to Waves raised by Ships.*—The principle now stated has already been applied to the explanation of the additional resistance, increasing faster than the square of the velocity, which is met with by vessels that move faster than the *terminal speed* of the waves which they raise, that terminal speed being the speed corresponding to the length of entrance, according to Mr. Scott Russell's system. It has now to be shown how the depth to which the disturbance produced by the vessel extends must affect the form and motion of the waves which travel along with her. Let A n in fig. 1 represent a half-breadth plan of a ship; A her cutwater; B her sternpost; and let C be the point where the crest of a "wave of displacement" is raised by the bow of the vessel. Draw D C to represent the speed of the ship; draw, as before, a semicircle on D C as a diameter, and lay off D E to represent the speed of advance $(\sqrt{g\,k})$ corresponding to the virtual depth of disturbance (k); then C E perpendicular to D E will be the position assumed by the wave ridge as it advances obliquely from the ship. (The geometrical construction may be performed by means of the enlarged diagram, fig. 2, for convenience.) It is probable that the virtual depth (k) bears some definite relation to the *mean depth of immersion* of the part of the ship by which the wave is raised, meaning by that mean depth the displacement of the part in question divided by the area of its plane of flotation; but what the precise nature of that relation is still remains to be ascertained by experiment and observation. Let C′ in fig. 1 be the point where the crest of a "wave of replacement" follows the ship. Then in fig. 2 lay off D E′ to represent the speed of advance corresponding to the virtual depth of disturbance (which will be certainly not less than, and in many cases greater than, the virtual depth in the wave of displacement); then the position assumed by the wave ridge at C′ (fig. 1) will be parallel to C E′ in fig. 2. To illustrate the same principles further, suppose the ship to be driven by paddle wheels; and let C″ in fig. 1 be the point where a wave crest is raised by the paddles. Then in fig. 2 lay off D E″ to represent the speed of advance corresponding to the virtual depth of the disturbance of the water by the paddles (which will probably be equal, or nearly equal, to their depth of immersion); then the position assumed by the wave ridge at C″ in fig. 1, will be parallel to C E″ in fig. 2. The data according to which the figures are drawn are as follows:—

Fig. 2.

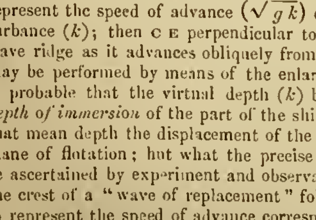
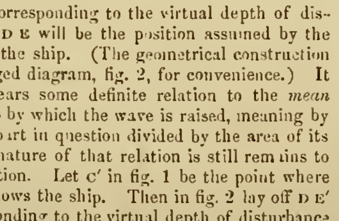


Fig. 3.



Velocity of ship, D C, 24 feet per second.

	Virtual Depth. Feet.		Speed of Advance. Feet per Second.
Wave of displacement at C, . . .	$k = 4{\cdot}5$	...	$a = 12$
Wave of replacement at C′, . . .	8·0	...	16
Wave raised by paddle at C″, . .	2·0	...	8

Terminal Position and Forward Curvature of Wave Ridges.—According to the principle stated in Article 5, the disturbance of the particles produced by the passage of the ship is gradually communicated to layers of water at greater and greater depths, and the speed of advance of each wave gradually approximates to a terminal speed, depending on the periodic time, in the manner stated in Article 4. The periodic time of any one of the waves raised by a ship is equal to the length of that wave as measured parallel to the line of flotation divided by the speed of the ship. In symbols, let L be the length, so measured, and c the speed of the ship, then $T = \frac{L}{c}$. The length of the wave of displacement is either equal to, or bears some definite relation to, the length of the ship's entrance; that of the wave of replacement bears some definite relation to the length of her run. To find the terminal position of one of these waves, lay off D F, in fig. 2, to represent its terminal speed as calculated from its period, then the terminal position of the wave ridge will be parallel to C F in fig. 2, as exemplified at c and c' in fig. 1. Hence each of the wave ridges raised by a ship bends forward as it spreads, approximating by degrees to the position corresponding to its terminal speed in a manner which is illustrated by the curves C c, C′ c', C″ c'', in fig. 1, and which must be familiar to every one who has watched the waves that follow a steam vessel when calm weather and smooth water enable their figures to be distinctly seen. The rate at which the forward bending of the wave ridges goes on remains to be determined by observation; for it depends upon the still unknown rate at which the disturbance of the water is transmitted downwards. The data as to periodic time assumed in the construction of the figure are as follows:—

Length of waves of displacement and replacement, $L = 96$ feet.

Speed of ship, $C = 24$ feet per second.

Period $T = \frac{L}{C} = 4$ seconds.

Terminal speed, $b = D\,F = 5{\cdot}12 \times 4 = 20{\cdot}5$ feet per second, nearly.

9. *Retarded Waves.*—The particles of water near the vessel may sometimes, especially if she has full bows, be forced to move in waves which travel for a short time at a speed greater than that corresponding to the virtual depth, and in some cases greater than the terminal speed. Such waves, as they spread outward from the vessel, are rapidly retarded, until they assume their proper free speed, and their ridges present a backward curvature, as in fig. 3.

Conclusion—Experimental Data Desirable.—In the absence of precise experimental data as to the figures of the wave ridges which travel along with ships, it has been impossible, in the present paper, to do more than to point out the nature of the principles upon which those figures depend, and to show the general agreement of the results of the theory with those of observation. It is obviously very desirable that accurate observations should be made of the positions and curvatures of those wave ridges as raised by vessels of various figures at various speeds, because, when we have those observations, the theory will enable us to deduce from them values of the depth to which the water is disturbed by the passage of the ship, and of the rate at which the disturbance is transmitted downwards to greater depths; and it is very probable that the knowledge thus obtained may lead to some results which may prove useful in practice.

ON LIQUID FUEL.

By Captain J. H. Selwyn, R.N.

The subject of my paper, "Liquid Fuel," is one that possesses great interest to persons in every branch of manufacture, especially to those who are in any way engaged in the distillation of coal, mineral oil, or wood, or the products of these substances; but to none of these are offered the enormous advantages attendant on a successful combustion of it that may be obtained by the constructors and employers of steam ships.

Therefore, I venture to claim the attention of the great body of naval architects here assembled, while I attempt to communicate the results of studies and experiments, which since my first paper on the subject, read before the United Service Institution in 1865, have led to the magnificent conclusion, practically demonstrated, that the number of days' fuel carried by steam ships can, without difficulty or danger, and with materially diminished expense, be at least tripled. I know that with many persons the very idea that the advocate of progress who addresses them on a particular subject is, I had almost said, has the misfortune to be, an inventor on that subject, is sufficient to close the door of receptivity in their minds, and dispose them to regard arguments and facts they would else have readily accepted, as objects of the deepest distrust, the most jealous suspicion.

Therefore I shall commence by declaring that on this subject at least I am not an inventor. I have, indeed, watched carefully the development of the idea. I have balanced closely the advantages to be gained and the difficulties to be met; but I trust that I have decided dispassionately, and I am able to say with confidence that I have at least not overvalued the importance of the subject.

Those who are anxious to follow the path that I have pursued will find my earlier papers in the journal of the Royal United Service Institution. They will also find there what I could never have given them—a paper far more valuable than any of mine, in which Professor Macquorn Rankine gives the grammar of the subject, and leaves nothing to be desired by those who wish to understand the combustion of liquid fuel, so far as it has yet been carried by theory. While I range under the head of liquid fuel every kind of fluid hydrocarbon, I must beg you to recollect that the substance of which I shall relate the success, is not petroleum, is not inflammable under a temperature of 240° Fahrenheit, and having a specific gravity greater than that of salt water, has none of the dangerous properties which are supposed to militate largely against any adoption of such fuel in steam ships. If a piece of thoroughly red-hot iron be inserted into a cask or bucket containing the fuel, there is an escape of disagreeably smelling white smoke, which will inflame quietly on the application of a flame in the open air and burn off. If such an experiment were tried in a closed room, and a flame (as of a candle) were there, supposing that the air present were kept in the proportion of from 9 to 13 parts to one of gas, neither more nor less, then it is possible for a gas explosion to take place. But a good deal of trouble must be taken in order to secure such a result. It is most unlikely to occur in any steam ship, even where that steam ship is attacked with red-hot shot; and the effect, even when it did occur, would scarcely be so great as the explosion of one 300 lb. cartridge. In case of a ship catching fire it is infinitely less dangerous than coal, besides not being liable to spontaneous combustion—for it may be run out into the sea and will sink there, or even if run into the hold, where some bilge water existed, it would sink below it, or rather raise the water to the surface, and would not take fire under those conditions, even when the ship is burning fiercely above it. Supposing a quantity, say a ton of the oil, were run out on a deck of pine, you could not inflame it by any device short of raising the temperature of the wood to 240 degrees, and the oil with it, and then applying flame—a spark would not light it. Even while burning a few buckets of water would extinguish the whole, and it must be remembered that no hydrocarbon must ever be used as fuel for ships from which the light oils have not been removed, or of which the specific gravity is not rather greater than that of salt water. A ready test of this is to soak a pine wood shaving in it, and throw it overboard. It will sink rapidly if the specific gravity is right. In the contrary case it will float. There may be other forms of danger which have not occurred to me, and I hope the discussion may bring them out; but I do not profess to bring before you a fluid substance which is not inflammable under any conditions, since in that case it could certainly not be a fuel.

The particular hydrocarbon to which I wish to direct your attention is known as "creosote," "dead earth oil," or "acid-foots." The first is the name I prefer, as being most generally known, and the next part of the subject to which I shall refer is the price at which it can be obtained. Creosote is the refuse product of the distillation of tar for chemical purposes. About 6,000,000 gallons of it are made, of which a great part is thrown away, in the London district alone. I find that the present price is about ¾d. per gallon, or 13s. 9d. per ton. The total production, as a waste or refuse, in these islands probably reaches 60,000,000 gallons annually. But this is of the less importance, as it is certain that any required amount can be produced in answer to a demand without greatly enhancing the price—first, wherever coke is made; secondly, wherever shale exists; thirdly, wherever coal distillation is carried on to obtain illuminating oils, of which this is in one form a refuse; and lastly, from the refuse of petroleum itself, refined for the same purposes. The supply is, indeed, much more widely distributed, more easily got at, and much less likely to be exhausted than that of coal, if we put any faith in the prophecies on that subject of the alarmists. I will just remark in passing how bounteous an answer this new fuel is likely to prove to those who doubted the care of the Creator for his creatures, and thought that we might soon be left without a basis for our manufactures, without comforts of which long use had made necessities to a large portion of the human race. The price of an article being always regulated by the facility of production, it is, I think, sufficiently obvious that, although no one can be expected to sell diamonds as pebbles after he has discovered them to be jewels, and so we must be prepared to pay more than 13s. 9d. per ton for a fuel, every ton of which equals for our purposes 3 tons of coal at least; yet no such prohibitive rise of price is to be expected as would prevent our using the liquid fuel wherever and whenever it is desirable. We must, besides, allow that it would be difficult to estimate what price would be too high in men-of-war for a fuel capable of doing three times as much as coal, bulk for bulk, while possessing so many collateral advantages as I shall show can fairly be claimed for it.

The first of these, if I mistake not, in the estimation of naval architects, is the power it gives them of arranging the weight to be carried, as seems most desirable, in the spaces hitherto necessarily left vacant, and thus turning the cellular structure of iron or steel ships to the best advantage; and, secondly, the power of replacing the expended fuel by water ballast, so as to keep the ship constantly at her best trim, whereas coals or other solid fuel must be placed in large spaces, whence it can be brought to the engine-room by the laborious operation of trimming or shifting the coal. A liquid fuel may be stowed in tanks, no one of which need carry more than a few tons, and which may be placed anywhere in the bottom of the ship.

In many instances the cellular compartments of the bottom can be made use of without any tanks other than those for the day's supply, which should generally be so far above the level of the fire-doors of the furnaces as to gravitate naturally towards them through pipes, from whichever may be the higher or weather side. Pumps attached to the engine will feed these as the boiler is fed with water by others. But these are only suggestions on subjects of which, probably, most of those who are here are far better informed than myself, and I therefore pass on to other parts of the question, feeling sure that the mode of stowage will soon develope itself when the advantages to be gained by the use of liquid fuel are thoroughly appreciated.

I now beg to refer you to the diagram, as well as to the apparatus itself, which can be handed about for inspection, in order to convince you that no complicated machinery, liable to premature destruction, need be used in order to produce results in every way satisfactory. Neither will it be necessary to make any important changes in existing boilers before they can burn this fuel, while, at the same time, they will remain perfectly ready again to burn coals, should such a course be deemed advisable. I do not say that the construction of future boilers for the express purpose of burning the creosote, will not be subject to considerable modification and improvement. In all but vessels designed for cruising, as men-of-war, or for the longest voyages of commerce, a great saving in boiler space will probably soon be effected; but the liquid fuel can be burnt well, and the necessary apparatus can be cheaply and quickly applied to any of the forms of boilers now known. There is here no smoke nor any deposit of unburnt carbon. There will be no ashes to be got rid of, nor will there be any drawing of the fires. Banking up will be replaced by a few of the injectors being kept burning under the largest boiler, and immediately the tap is turned off the fire is out. One thing requires to be noted in the manipulation. The oil tap must always be turned *on* after the steam, and be turned *off* before it. If the oil is allowed to drop on a very hot surface at the mouth of the furnace, but which is not hot enough to light in the absence of flame, there will be gas formed, and a gas explosion will take place, much as occurs when a lively fire of coal in a steam furnace is choked with a quantity of slack. It is not dangerous, but it will singe the stoker's whiskers, and very likely frighten others who are standing round. It has never occurred twice with the same person, and may be accepted as a warning to the stoker that he must do his work intelligently, though when once set going he may leave the engine-room, if he likes, till the state of the water or something else requires his attention. As the economic value of the fuel depends on the proper admixture of fuel, air, and the steam which induces the air current round the jet, it is most satisfactory to find that even in the little steel launch boiler, 6 feet 6 inches long by 2 feet 6 inches wide, we can regulate the supply of each so exactly that a tenth of an inch in the turning of either tap will make the difference between no smoke at all, the yellowish smoke of unconsumed carbonic oxide, or the dense fumes of unburnt hydrocarbon. While the pressure of steam is rising attention must be given either to shut off the steam or to increase the oil supply; but once the working pressure is reached there is no more to do unless the vessel alters her course or the wind changes, so as to require a greater or less supply of air to be artificially driven in by the steam-jet. In the roughest application of the principle all that is necessary is to bore a hole above the fire-door, to take two iron pipes, say ½ inch, and bend them so that they look into the furnace one over the other. Then to the lowest connect the steam, to the upper the oil, and your fire-bars having been covered with a thin bed of glowing ashes the boiler is ready to work night and day as long as your oil lasts. The bed of ashes will require renewal about once in the twenty-four hours; and a 35 horse-power boiler, of the ordinary Cornish form, with Galloway tubes at the back, has now been at work night and day without intermission at Hackney Wick since Christmas last, doing considerably more duty, with 230 gallons of liquid fuel per day, than it had previously done with 3 tons of coal. In this case the fuel is a refuse product of the works, which are for nitric acid, and has the name of coarse naphthalin. It is melted from its original solid form in tanks by waste steam pipes, and is then conducted to the furnace. The proprietor of the factory told me that whereas he had been paying 72*s.* per day for fuel, he now only paid 5*s.*, and was better satisfied with the other results. The water evaporation has here been carefully measured for a fortnight, and amounts to 23 lb. of water evaporated by every pound of fuel. *This*, gentlemen, is no mere experiment, but is a practically proved fact; and I have permission from the owners of two factories at Hackney Wick to invite any one, who may be desirous of seeing for themselves, to accompany me to the works and inspect the two systems in full operation. In the one I am now speaking of the combustion is attended with no smoke, and but little flame or light. A blue glow of carbonic oxide burning pervades the furnace, and through this, like meteors, dart vivid coruscations of incandescent carbon. The bed of ashes remains glowing, but is more blown than burnt away: and as the ash-pit is not closed up, perhaps an undue, certainly an unknown, quantity of air enters. This may, or may not, be in excess of the quantity actually burnt, but it is certain that every excess is injurious to the effective heating power of the boiler in a very marked degree, and should be carefully avoided. Still this, which is so roughly done, gives us nearly, if not quite, the whole theoretic value of the fuel, according to Messrs. Favre and Silbermann, and to Professor Rankine's paper to which I have alluded; 27 lbs. of water being given as the result of the perfect combustion of such mixtures even in the gaseous state. If, then, we can get 23 lbs. of water evaporated by 1 lb. of fuel, we see easily that, independently of a more convenient stowage, and other advantages, to which on this occasion I have only cursorily alluded, as the best results with coal at sea fail to give us much more than 7 lbs. of water evaporated by 1 lb. of coal, three times this, or 21 lbs., has been exceeded, is being daily exceeded, and ought never to be considered impossible or even difficult of attainment in our steamships for the future.

With these—which I cannot but call magnificent results—I might have been fully satisfied; but I must ask your patience for a few minutes more while I place before you, as succinctly as possible, facts, or what seem such, that have startled even me, and which carry with them, if true, the most important, the most incredible consequences. After satisfying my gaze with what I considered a wonderfully perfect combustion at the nitric acid factory, I went to another, not a hundred yards away, for tar distilling, and saw another Cornish boiler, this time without Galloway tubes, but like the other, about 35 feet long and 7 feet diameter. Here the furnace end of the boiler was entirely changed, *i.e.*, the firebars had been taken out, and the end built up with firebrick. The firedoor was inserted in this, about in its usual place, and above it was a conical hole by which the jet or injector entered. A good deal less air was thus admitted, and only in close combination with the jet. Inside all the firebars had been taken out, and where the jet played there was a sort of cupped arrangement of the firebrick, looking very like the opening for fire into a common brick kiln or clamp. Here a flame of the most vivid whiteness was producing a melting heat on the firebrick, and in the centre was a deposit of what appeared to be solid carbon, at a white heat, of a crateral form, gradually increasing at the lip. You may judge of my astonishment when, on inquiring of the manager about the fuel used, I was told, first, that about 3 tons of Butterley coals had been daily used in the twenty-four hours to fire the boiler, and then, taking me into the office, he showed me the account of the number of gallons of oil used during the week from March 7 to March 14 as 768, or an average of 109$\frac{6}{10}$ gallons per day. That is, that 1090 lbs. of oil (this was creosote) were steadily doing the work previously done by 6720 lbs. of coal. I do not ask you to believe this on my statement, but I ask you to examine for yourselves. I need scarcely tell you I soon revisited this wondrous sight, and used every means in my power to find out the truth. I have not been able, engaged as I was at Woolwich in fitting the little oil-burning boiler to the steam launch there, to sit by the boiler and see for myself, as the manager kindly proposed, but I think it well worth doing. On my second visit I found that during that week they had burnt 160 gallons a day, instead of 109 on the average; and I rather attribute this to the fact that the brickwork in front was no longer so tight as it had been, and was admitting more air than could be burnt. It seems a most extraordinary thing that, whereas in the other boiler, when the carbonic oxide was formed and burnt off perfectly, the evaporation was 23 lbs., here, where nearly the whole of the carbon appeared to be dropped, the evaporative effect was double, and duty amounting to more than 46 lbs. of water to 1 lb. of fuel appears to have been secured. Now this, if true, is no less than double the theoretic calorific value of the material, and I hope some one during the discussion will give some rational explanation other than denying that anything of the kind ever took place. If not, I will myself ask a question of the chemists, which may perhaps help to an elucidation of the facts, should they turn out to be reliable and confirmed by further observation.

Never was there such a discovery for steam, if it be true, for it amounts to this, that a vessel formerly able to carry ten days' fuel would now carry no less than sixty.

I owe it, in the first place, to the chief constructor (Mr. Reed's) appreciation of progress, that the Admiralty have sanctioned the fitting of a steam launch, which is just completed; and although in her, tied down to the old dimensions of the former boiler, as we were by the nature of the case, we do not expect to show great economy, yet of this there will be a fair amount, and other features of the system are conclusively demonstrated. I hope that the next tests at Woolwich will show the high evaporative efficiency under a tubular marine boiler, and satisfy even the chemists that we know what we are about.

ON THE TREATMENT OF STEEL PLATES.

By Henry Sharp, Esq., of the Bolton Steel and Ironworks, Bolton-le-Moors, Lancashire.

During the last four or five years there has been a very rapid increase in the use of steel in almost every description of engineering work both in this country and abroad; and taking into consideration the fact that it is not yet five years since Bessemer steel began to be manufactured on a large scale, it must be allowed that its use has been attended with wonderful success.

It is being extensively used in the form of rails, which manufacturers have to submit to tests of sudden concussion by falling weight, and also of prolonged subjection to constant and repeated strains such as no iron rails could sustain.

It is also being used with most satisfactory results in the form of axles, tyres, piston rods, &c., and in a few instances locomotive boilers have been constructed of it; but these have not been sufficiently long at work to enable an opinion to be formed of its advantages for that purpose.

There has, however, been a very large number of stationary boilers made, some partially, and some entirely of steel, which are giving most satisfactory results, both as regards economy of working and repairs; and in proof of this I may state that three firms in Lancashire have made among them 277 boilers entirely of steel, and 152 composite boilers, and the demand for them is increasing daily.

The use of steel is also increasing in the construction of ships, and it has been adopted exclusively in cases where light draught of water and great speed have been required; and the manner in which this material has withstood the effects of storms and collisions proves that it is highly applicable to shipbuilding purposes when of good quality.

More disappointments have, however, been experienced in the use of steel plates than when used in any other form, and this may be attributed to two causes; first, that in many cases the lowest price has secured the order, and plates of an inferior and brittle quality have been supplied; and, second, that too high a tensile strength has been required, which can only be obtained at the expense of ductility.

There is not any branch of the steel manufacture in which it is necessary to use better materials, and to exercise greater care, than in that of plates; and in consequence of the want of one or both of these requisites, steel plates of inferior quality have found their way into the yards both of boiler-makers and shipbuilders, which have failed in course of construction, and have caused an opinion to go abroad that steel plates are not to be relied upon; and there can be little doubt that this feeling has prevented steel being used in many cases where it could have been with great advantage.

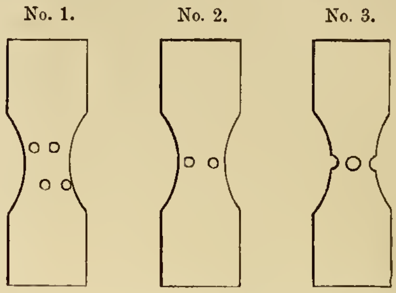
Plates of good quality should possess the following properties, viz., ductility, tensile strength, and homogeneity; and in order to secure these in steel plates great care should be taken in the selection of the irons from which the steel is made, to insure them being as free as possible from sulphur and phosphorus, and not containing above a certain percentage of silicon; and long experience has proved that the best and most uniform results are obtained in the converting process when a mixture of several brands of pig iron is used.

It is also necessary to select the steel, just in the same manner as the best makers of iron plates select the puddled bars by breaking them, and determining the quality by the fracture; but with steel this is now generally done by the chemist, who analyzes every cast for carbon, after which it is appropriated to the various purposes for which it is most suited. The ingots are then hammered, rolled into plates, and annealed; but as carbon is not the only element that tends to make steel brittle if in excess, it is desirable to test every plate for ductility by bending one or more shearings from each cold, and this system has been carried out for a length of time with most satisfactory results.

The tensile strength of steel depends almost entirely on its hardness; and experience has proved that plates with an ultimate strength of from 33 to 35 tons per square inch are the most desirable, as they possess sufficient ductility to render them safe under all circumstances, and are easily worked. Each plate being made out of a solid ingot insures homogeneity, and the largest plates that it is practicable to roll can be made with a perfect freedom from lamination or blister.

There have, however, been causes over which the maker has had no control, which have helped to bring about the distrust felt in many quarters on the subject of steel, particularly plates, viz., the manner in which it has been treated.

I can speak from personal observation on this point, having seen it punched and sheared by machines in such very bad order that it was a wonder that any material could be found to stand the ordeal. There is no doubt that punching injures all plates more or less, and the harder and more dense the material the more it is injured; consequently steel plates, with a tensile strength of from 33 to 35 tons per square inch, suffer more than iron plates with a tensile strength of 20 to 22 tons per square inch; and this fact has impressed itself so strongly on the minds of some of our engineers, who have given much attention to the subject, that they have altogether abandoned punching in favour of drilling, and the wisdom of this step is fully borne out by the following experiments conducted under my superintendence in the month of May last:—



Punched holes $\frac{5}{8}$ inch diameter, $1\frac{1}{2}$ inch centre.

A steel plate was cut up into pieces 7 inches broad and 23 inches long; three of these were punched, and three drilled, across the middle with $\frac{5}{8}$ inch holes $1\frac{1}{2}$ inch from centre to centre, arranged for single and double rivetting; each piece was then carefully shaped out by machine to the form shown on the preceding diagram, after which the nett areas of metal left across the holes were carefully measured.

When pulled asunder in a lever machine by dead weight they give the following results:—

Number of Test.	Thickness.	Area.	Breaking Weight on Lever.		Weight per Square Inch of Section.	Weight per Square Inch of Section.
			Tons	Cwt.		
1 D.	$\frac{5}{16}$	0·5437	19	3	35·22	
1 P.	$\frac{5}{16}$	0·55625	14	17	—	26·690
2 D.	$\frac{5}{16}$	0·55	20	10	37·27	
2 P.	$\frac{5}{16}$	0·5625	13	$5\frac{1}{2}$	—	23·735
3 D.	$\frac{5}{16}$	0·5466	19	18	36·40	
3 P.	$\frac{5}{16}$	0·5593	12	$12\frac{1}{2}$	—	22·570

Thus proving that punching deteriorated the tensile strength of steel plates $\frac{5}{16}$ inch thick to the extent of from 26·4 to 37·8 per cent., as compared with drilling; or taking the average of the experiments, to the extent of 33 per cent.

There are, however, so many cases in which punching is much more convenient and cheaper than drilling, that it was considered very desirable to try and overcome the difficulty attending the former process; and with this view the fractures of punched plates, some broken by tensile strain and others by being bent across the holes, were very carefully examined with a magnifying glass, and for a certain distance round each hole (the thicker and harder the plate the greater the distance) the steel had the appearance of being harsh and brittle, which led to the conclusion that annealing might overcome the difficulty; and some pieces off the same plate as those used in the previous experiments were prepared with punched holes, and were afterwards annealed, and it was found that the breaking strain rose to 35·86 tons per square inch, that is to say, the annealing restored the plate to its original strength.

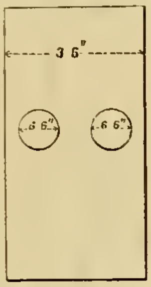
The process is very simple, and can be carried out with very little expense, all that is required being a slow furnace into which the plates can be put after being punched, and allowed to remain until they have got to a dull red heat all through; they are then brought out and laid on a brick or sand floor, and covered over with fine ashes or dry sand to prevent them cooling either too rapidly or unequally.

I do not wish to be understood as advocating punching and annealing in preference to drilling; but in cases where drilling is inconvenient or too expensive, the process described may be resorted to with every confidence; all subsequent experiments having given the same results, which have been fully confirmed by a series of elaborate tests conducted at H.M.'s Dockyard, Chatham, the results of which I am able, through the courtesy of Mr. Barnaby, assistant constructor of H.M.'s Navy, to lay before you.

In these experiments, eight plates $\frac{1}{2}$ inch thick were taken and four holes $\frac{5}{8}$ inch diameter were punched in each. The plates were then cut in two, so that each plate made two test pieces, one only of which was annealed.

The whole sixteen plates were torn asunder in an hydraulic testing machine, and the eight unannealed plates gave an average ultimate tensile strength of 21·097 tons per square inch of section, whereas the average of the eight annealed plates was 32·839 tons per square inch of section, being an increase of 11·742 tons per square inch, or 55·66 per cent.; and it will be observed from the following table that the annealed plates showed a much greater uniformity in strength than the unannealed, the difference between the two extremes in the one being 5·416 tons as against 9·372 tons in the other. It will also be seen that the annealed plates stood the usual forge tests very much better than the others.

No. of Sample.	Size of Sample.	Breaking Strain.				Breaking Strain per Square Inch.	
						Annealed.	Unannealed.
		Tons	Cwt.	Qr.	Lb.		Tons.
1 A.	2·28 × ·475	21	0	0	0	—	19·39
1 A.	2·28 × .475	35	15	0	0	33·010	
2 A.	2·33 × ·47	28	17	2	0	—	26·369
2 A.	2·23 × ·475	31	17	0	0	29·981	
3 L.	2·18 × ·47	23	0	0	0	—	22·460
3 L.	2·23 × ·48	37	7	2	0	34·929	
4 L.	3·23 × ·47	23	17	2	0	—	22·781
4 L.	2·23 × ·48	37	17	2	0	35·397	
5 A.	2·23 × ·475	20	0	0	0	—	18·885
5 A.	2·23 × ·48	32	17	2	0	30·724	
6 A.	2·28 × ·475	19	10	0	0	—	18 005
6 A.	2·28 × ·475	33	17	2	0	31·278	
7 L.	2·23 × ·475	18	0	0	0	—	16·997
7 L.	2·23 × ·475	35	10	0	0	33·522	
8 L.	2·28 × ·475	25	17	2	0	—	23·891
8 L.	2·23 × ·475	35	17	2	0	33·876	



REMARKS. — Steel plate, $\frac{1}{2}$ inch thick, with holes $\frac{5}{8}$ inch diameter, punched as per sketch. The holes were punched before the plates were cut for testing.

FORGE TESTS, COLD.

	Proof.	
With the grain, ...	70°	Bent to 74°
Across, ...	40°	Broke off at 30°
With the grain, ...	*70°*	*Bent considerably over proof without fracture.*
Across, ...	*40°*	

Note.—The data relating to the annealed portions are shown in italics.

Having fully proved the great advantages to be derived from annealing punched steel plates, it appeared to me the next point to ascertain was if the results arrived at in the experiments just described could be relied upon when the work was carried a step further, and with this view a number of steel plates were prepared with rivetted joints of various construction, as shown by the diagram, on the next day; the pieces were all cut from one plate, the lengthway of the grain; one half were drilled, and the other half punched and annealed, after which they were all rivetted across the full width by a Garforth machine, and then reduced in the middle on a shaping machine to an uniform width.

The plates were $\frac{5}{16}$ inch thick, and the rivets $\frac{9}{16}$ inch diameter, placed 1$\frac{3}{4}$ inch from centre to centre, this being the rule generally adopted in making steel boilers, which, I may remark, are all double rivetted.

The rivets were made of the "best best" double-worked rivet iron.

The plate was proved to have an ultimate tensile strength of 36·22 tons per square inch, and the elongation was 1$\frac{3}{16}$ inch in 6 inches, which is about the average in plates of this strength.

When these plates came to be tested, the rivets gave way in every instance but one, viz., in No. 7, with punched holes, where the plates gave way across the upper row of holes with a load of 39·12 tons per square inch of nett sectional area of plate, thus proving that with this one exception the iron rivets were too weak. These same plates were then rivetted together as before, but with mild steel rivets instead of iron, and when tested gave the following results:—

$\frac{5}{16}$ *Steeel Plates Rivetted with Steel Rivets.*

No of Plate.	Section between Rivets.	Breaking Load.	Load per Sq. in. of Section.	How broken.	Sectional area of Rivets.	Load per Sq. in. on Rivets.
		Tons.	Tons.		In.	
1	0·78125	28 3	36·22	Elongation.	1$\frac{3}{16}$	
2 D.	0·76170	19·0	24·928	Rivets sheared.	0·745	25·53
2 P.	0·754	19·8	26·254	Do.	0·7653	25·87
3 D.	0·7617	32·25	42·33	Do.	1·2425	25·95
3 P.	0·754	27·9	37·0	Do.	1·275	21·88
4 D.	0·7617	18·05	23·68	Do.	0·744	24·26
4 P.	0·754	18·5	24·53	Do.	0·7653	24·17
5 D.	0·7617	29·9	39·25	Plate and rivets.		
5 P.	0·754	32 9	43·63	Plate.		
6 D.	0·7617	27·9	36·62	Rivets sheared.	1·488	18·75
6 P.	0·754	30·9	40 98	Plate.		
7 D.	0·7617	32·7	42·93	Do.		
7 P.	0·754	29·5	39·11	Do.		

Average diameter of rivets in punched holes = 0·57 inch.
" " drilled " = 0·5625 inch.
Area of $\frac{9}{16}$ inch drilled hole = 0·2485 ; area of punched hole, 0·255.

From this it will be seen that in Nos. 2 and 4, with single rivetted joints, the rivets sheared with an average load of 24·848 tons per square inch on the nett sectional area of the plate, and of 24·96 tons per square inch on that of the rivets.

No. 3, double-rivetted lap joint: the rivets sheared in the drilled plate, with a load of 42·33 tons on the nett sectional area of the plate, and of 25·95 tons on that of the rivets; in the punched plate with a load of 37 tons per square inch on the nett sectional area of the plate, and of 21·88 tons on that of the rivets.

No 5, double-rivetted joint, with one welt: in the drilled plate both plate and rivets gave way with a load of 39·25 tons per square inch on the nett sectional area of the plate.

The punched plate gave way through the holes with a load of 43·63 tons per square inch on the nett sectional area of the plate.

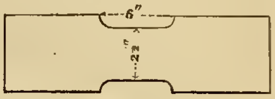
No. 6, single-rivetted joint, with two welts: in the drilled plate the rivets were double-sheared with a load of 36·62 tons per square inch on the nett sectional area of the plate, and of 18·75 tons per square inch on the area of the rivets.

The punched plate gave way through the holes with a load of 40·98 tons per square inch on the nett sectional area of the plate.

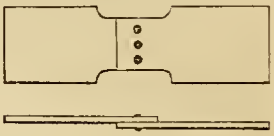
No. 7, double-rivetted joint, with two welts. Both these plates gave way through the holes—the drilled plate with a load of 42·9 tons, and the punched plate with a load of 39·11 tons, per square inch of nett sectional area.

Taking all those plates that gave way through the holes, we find that the drilled plates gave an average ultimate tensile strength of 41·075 tons per square inch, and the punched plates of 41·24 tons per square inch, from which it may fairly be assumed that rivetted joints in steel plates with punched holes are quite as strong as with drilled holes, if proper precautions have been taken to anneal the plates after punching.

No. 1.



No. 2.



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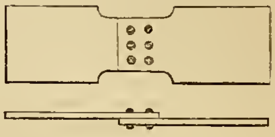

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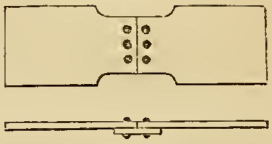

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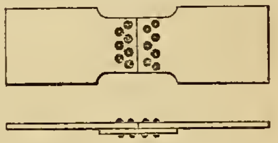

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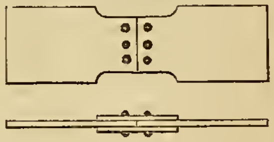
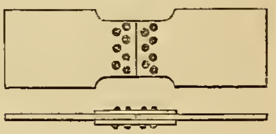
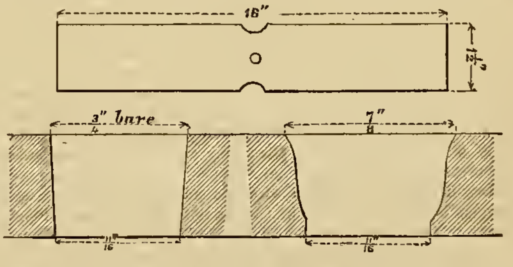


No. 7.



Whilst making these experiments, it was suggested to me that steel plates might be punched with holes sufficiently taper to do away with the necessity of countersinking the holes with a drill, and also that this method of punching would injure the plates much less than that generally adopted. In order, therefore, to test it, a steel plate $\frac{1}{2}$ inch thick was taken and cut in two. One piece was punched across the middle with holes $\frac{11}{16}$ inch diameter, the punch and die used being of the usual proportion, the clearance being a bare $\frac{1}{16}$ of an inch; the other piece was punched with the same punch, but the die had a clearance of $\frac{3}{16}$ of an inch, being $\frac{7}{8}$ inch diameter, the holes formed being taper. The plates were then cut on a planing machine into strips, and when tested gave the following results:—



No. of Plate.	Diameter of Punch.	Diameter of Die.	Nett width across solid.	Nett Section in sq. inch.	Load on Plate.		Load per sq. in. nett Section.	Average load per sq. inch.
	In.	In.	In.		Tons	Cwt.		
1	$\frac{11}{16}$	$\frac{7}{8}$	1·75	0·8476	27	6	32·208	32·527
2	$\frac{11}{16}$	$\frac{7}{8}$	1·6562	0·8022	26	7	32 847	
3	$\frac{11}{16}$	$\frac{3}{4}$ bare.	1·8593	0·9007	23	7	25·924	26·004
4	$\frac{11}{16}$	$\frac{3}{4}$ bare.	1·8125	0·8779	22	18	26·0849	

	In.
Thickness of plates, ...	$\frac{34}{64}$
Pitch of holes, ...	$1\frac{5}{8}$
Plates not annealed after being punched,	

from which it will be seen that the ultimate tensile strength of the strips with ordinary holes averaged 26 tons per square inch of nett sectional area, whereas that of the strips with the more taper holes was 32·527 tons per square inch, showing a difference of 25 per cent. in favour of the taper punching.

The fractures of the strips with taper holes showed much tougher and more fibrous than the others, and it was observed that it took much less power to punch them.

I have not had time to make further experiments on this subject, but think it is well worthy of attention, particularly in cases where holes are required for countersunk rivets.

It is not my intention to occupy your time in pointing out the many and great advantages to be gained by the use of steel plates. There is no doubt that their use is extending rapidly in almost all engineering works, and I feel sure they will, in the course of a few years, be generally adopted, particularly in all cases where strength combined with lightness is required; but it is very essential that in all structures only steel of a thoroughly reliable quality should be used.

In conclusion, I wish to observe that all the plates used in the experiments described in this paper, were taken indiscriminately from among plates which were being rolled in the execution of orders, and the experiments have been conducted with an earnest desire, not only to determine the valuable properties of steel plates, but also to ascertain the causes of failure which have taken place, and, if possible, to find out a means of overcoming them.

INSTITUTION OF MECHANICAL ENGINEERS.

DESCRIPTION OF THE PAYING-OUT AND PICKING-UP MACHINERY EMPLOYED IN LAYING THE ATLANTIC TELEGRAPH CABLE.

By Mr. George Elliot, of London.

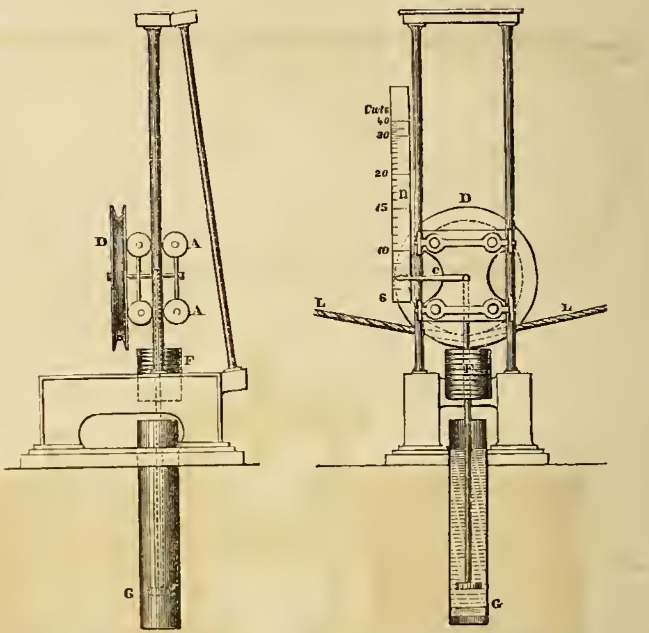
(Continued from page 27.)

The paying-out drum was also supplied with steam power for reversing its action and picking up the cable, should any fault occur requiring such an operation. This constituted one of the most important improvements over the arrangements of the 1865 expedition, in which it had been necessary to hand the cable along the side of the ship from the paying-out machinery in the stern to the picking-up machinery in the bow, on any occasion of requiring to haul in the cable; and it was during this hazardous process that the cable was broken and lost in the former expedition. In the present machinery the shaft, S, of the paying-out drum, P, fig. 10, was prolonged on one side for the purpose of forming a coupling to the picking-up arrangement. It was considered advisable to make all this part of the machinery sufficiently strong to work with, and if necessary even to break, the large grapnel rope, which had a breaking strain of more than 30 tons. The shaft, S, was therefore made in its smallest place 7½ inches diameter. There were three points to be specially considered in the design: first, that the moving parts of the machine should be kept as light as possible, so that the momentum of the moving mass in paying out should be as small as possible, and should therefore strain the cable as little as possible, either in case of any sudden and accidental mishap, or when the ship was pitching; and this was of vital importance. Secondly, that the picking-up arrangement should be capable of being brought into action at a moment's notice. And thirdly, that the strength of the machine should be sufficient to cope with a rope having the uncommon breaking strain of 30 tons. These various requirements were admirably met by the arrangements adopted in accordance with the designs of Mr. Clifford, the engineer of the Telegraph Construction and Maintenance Works, who had also worked out the design of all the machinery employed in the expedition.

In order that the machinery for paying out might be as light as possible, the picking-up motion was coupled direct to the shaft, S, of the drum itself, as shown in fig. 10; so that when the coupling was thrown out, the paying-out machine remained intact and as similar as possible to what would otherwise have been necessary if there had been no picking-up arrangement. This shaft and coupling had to be of the enormous strength necessary to bear a torsional strain of 30 tons, acting at a leverage of 2 feet 8 inches. The shaft ends were squared, and a large wrought-iron coupling, R, capable of sliding along, coupled the two shafts securely; and the application of this was simply the work of a moment. On the shaft, H, thus coupled to the drum shaft was fixed a large spur wheel of 7 feet 11½ inches diameter and 5 inches pitch: this pitch may at first appear excessive, but it is less than is in use for such exceptional strains. A train of gearing driving the pinion working into this wheel admitted of a ready alteration in speed and power, and was driven by a pair of trunk engines made by Messrs. Penn, having a nominal horse-power of 80, but working in this case considerably below that power, as the condensing part of the engine was dispensed with and the steam supplied by the ship's boilers was only 20 lbs. pressure. The whole of the spur gear, which was of a very perfect construction, was supplied by Messrs. Jackson, of Manchester, and was manufactured by their wheel-moulding machinery, which secured a remarkably true bearing surface on the teeth. The steam was conveyed to the engines by an 8-inch copper pipe of about 130 feet length; and as a considerable condensation was anticipated from such a great length of pipe, a separator and superheater were fitted close to the engines, so that they received their steam in about an ordinary condition.

In paying out the cable the portion in the after tank was first taken, in order to trim the ship, as she was considerably by the stern at starting; the fore tank was next emptied, and the middle tank left to the last, the ends of the cable from the several tanks having been spliced together originally in that order of connection. When each tank became nearly empty the ship was slowed down, and it was quite stopped for a short time whilst the paying out of the cable was transferred from one tank to another. This apparently rather delicate operation was effected on both occasions without the slightest difficulty. The whole of the cable in the three tanks was spliced up into one length before the paying out commenced; and the length between each tank was carefully laid in troughs of wet sawdust, so that it could be kept under electrical test; it was also from time to time thoroughly soaked with water. The total length of cable paid out was 1851 knots, and the time from shore to shore was fourteen days, giving an average of 132 knots per day paid out, and an average rate of 5½ knots per hour for the cable. The total distance run was 1669 knots, making the average proportion of slack paid out 11 per cent.

The paying-out machinery was in principle identical with that used in the previous expedition of 1865, the only difference being that the frames of the machines were now made much stronger, as also the drums and their shafts, since they were constructed for picking up as well as paying out; many special arrangements were also made which fortunately were never called into requisition. Only one mishap of any importance occurred during the entire expedition, and that was when a large quantity of the cable fouled in the tank and came up all together on deck in the night of Wednesday, 18th July, when about 700 knots had been laid. This entangled mass of cable was cleared after three hours' most exciting and anxious labour. The night was dark and rainy, and a heavy summer gale was blowing; and only with the greatest care could the ship have been kept steady during so long a time. Evidently no appliances in the machinery could have been made to meet so extraordinary an occurrence. The ship was furnished with signal whistles, worked by air pressure constantly supplied from a steam engine, so that orders could be transmitted immediately and with the greatest precision to either the engine room or the bridges and steering deck; and probably the ultimate success of the expedition in no small degree depended on this arrangement.


Figs. 11, 12.—Paying-Out Dynamometer.

End Elevation. Side Elevation.

During the whole time of the paying-out the machinery was most carefully watched at all points. The drums were fitted with rotometers, showing the amount of cable which had been paid out; and this amount was carefully noted every fifteen minutes in the ship's log, and the speed of paying out and the speed of the ship were calculated so that a right amount of slack might be allowed. If the ship were travelling too fast, the speed was immediately reduced in the engine room; and if too much cable was being paid away, a small addition to the weights on the drum breaks usually remedied this defect speedily: in fact the whole working of the machinery showed that every difficulty which presented itself was fully overcome. Varying winds and currents and many other circumstances caused constant watching from moment to moment to be increasingly necessary. When at length the shores of Newfoundland loomed in the distance and the laying of the Atlantic cable was at last a success, and when the electrical tests which had been constantly trying the condition of the cable proved that it had in no way whatever been injured by the machinery during fourteen days' constant working, then could all on board realize the success of so much labour and thought, the result of so many years of constant application and experience.

Picking-Up Machinery.—Probably no course made by a vessel across the Atlantic was ever more definitely known and accurately marked on the chart, than that made in the year 1865 by the *Great Eastern* during the attempt to lay the Atlantic cable. When the cable parted in that year, many days were spent in the attempt to recover it; this time was, however, by no means wasted, as the results then obtained proved not only the possibility but the certainty that the cable could be found and raised from the bottom. It was a bold experiment—that of grappling for a cable at the depth of 2 knots—and was altogether without precedent: sailors, engineers, and theorists had repeatedly declared it absurd; but the result of the actual trial of grappling proved at all events that it was not absurd, and showed that perhaps even the ultimate recovery of the cable was not hopeless. The difficult task of placing the ship in such a position that it should drift across the line of cable, was three times successfully accomplished in the attempts made in 1865 to raise the cable; three times the cable was hooked, and three times the swivels in the rope failed. For days the dragging was determinedly continued by Sir Samuel (then Mr.) Canning, the engineer in charge of the expedition, until every fathom of rope was exhausted, and there was then no hope left for that year. Sufficient, however, had been done to render it impossible that other attempts should not be made; and all who were present were only more thoroughly convinced than ever that a cable could be laid across the Atlantic, and most sincerely believed that the cable commenced in 1865 would yet be recovered and finished. It matters not here to relate the exertions which were necessary for persuading capitalists to proceed yet further in an undertaking considered by very many to be as impracticable as the search after the philosopher's stone; it is sufficient to know that the money was ultimately obtained, that the expedition was organized, and most important of all, that it was successful. It is intended now to describe the means and the machinery by which this grand result was attained.

Fig. 13.—Elevation of Picking-Up Drum.

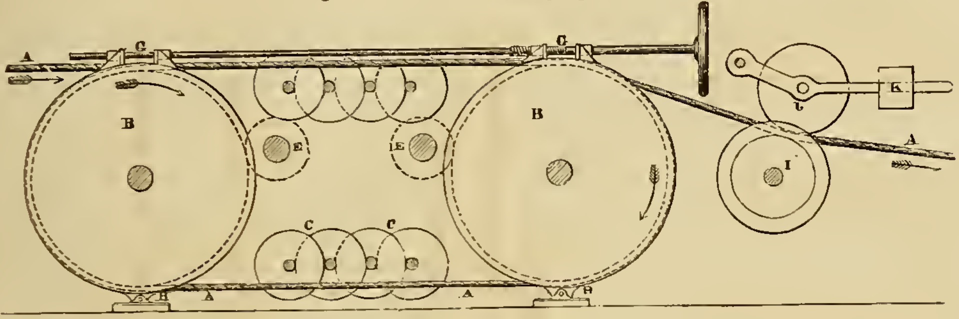


Fig. 14.—Plan of Picking-Up Drum.

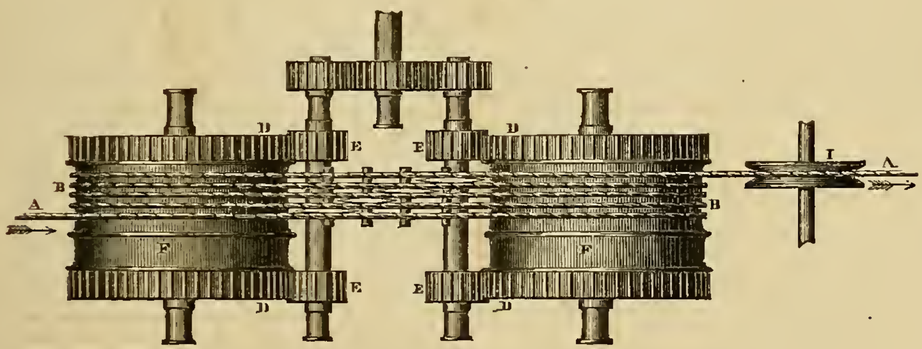
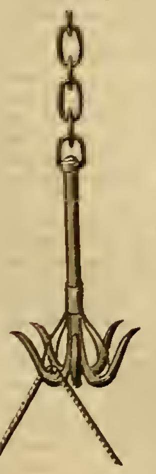


Fig. 15.—Grapnel.



The cable of 1865 had been laid with about 15 per cent. of slack, and this percentage of slack was the great source of hope for the successful recovery of the cable. It was calculated that if the cable could be raised to the surface without hooking it at more than a single point, there would be a hight suspended in the water of $9\frac{1}{4}$ knots in length, when in 2 knots depth of water, as shown in the diagram, fig. 5; and the horizontal distance, J J, would be 8 knots between the portions resting upon the ground, giving an excess of length of 15 per cent. in the suspended hight; and the results of the actual picking up proved this calculation to represent very closely the curve of the suspended cable. The size of the cable was $1\frac{1}{8}$ inch diameter, and its weight $35\frac{3}{4}$ cwts. per knot in air, and 14 cwts. per knot when immersed in water; the total weight of a suspended length of $9\frac{1}{4}$ knots in water was therefore $6\frac{1}{2}$ tons, but as the breaking strength of the cable was $7\frac{3}{4}$ tons, it would carry the weight of 11 knots of its own length in water before breaking. As, however, the possibility of its recovery in this manner in a single hight was generally considered to be out of the question, it was intended therefore to attempt raising it by degrees only. Three steamships were accordingly fitted with picking-up apparatus, the *Medway*, *Great Eastern*, and *Albany*, for the purpose of grappling for the cable simultaneously in three places: the *Medway* to the east and the *Albany* to the west of the *Great Eastern*.

The picking-up machinery was entirely new for this expedition, and was constructed for a much greater strain than the machinery employed in the attempts of the previous year. The grapnel, shown in fig. 15, was simply a very large ordinary boat grapnel made with five prongs instead of three; it stood about 4 feet high, was fitted with a swivel at the top, weighed about $2\frac{1}{4}$ cwts., and its prongs would carry a strain of about 8 or 9 tons without damage. Shackled to this was a 15 fathoms length of $1\frac{1}{8}$ inch chain, to which was fastened the grapnel rope. This rope was a most remarkable one, being $1\frac{7}{8}$ inch in diameter, and consisting of seven strands, six strands round one; each strand again consisted of six smaller strands of hemp, in the centre of each of which was a wire about 1-10th inch diameter. The rope was repeatedly tested, and was never known to break with less than 30 tons strain. Its weight in air was about 5 tons per knot, and in water $3\frac{1}{4}$ tons.

At the bow of the ship were fitted four iron girders carrying three cast-iron sheaves about 3 feet 9 inches diameter; these sheaves were all clear of the ship, and over the centre one the grapnel rope was led on board, as shown at K in fig. 2. The grapnel rope was led directly to the picking-up machine from the bow sheave, passing through a dynamometer so that the strain could be ascertained at all times. This dynamometer was similar to the one for the paying-out machinery described before, except that it was of a much heavier construction and loaded with a weight of 2142 lbs. The vertical travel of the dynamometer wheel was 5 feet, the horizontal length of deflected cable 30 feet, and the graduations of the scale ranged from 2 tons to 20 tons.

The picking-up machine was very powerful, as it had to cope with a rope of 30 tons breaking strain, and if necessary to break it. It is shown in elevation and plan in figs. 13 and 14. The two large drums, B, B, each 5 feet 8 inches diameter, were fixed on shafts parallel to each other at 11 feet distance apart from centre to centre. The grapnel rope, A, A, was passed four times round these two in the manner shown in fig. 13, passing away on the opposite side from where it entered on. The fleeting of the rope was effected by small disc rollers, C, C, placed on shafts between the drums, four above and four below; and each part of the rope was fleeted after leaving one drum before it entered on the other, thus keeping every portion of the rope clear of the rest. The fleeting required much more care in this machine than in the one for paying out, as the shackles and swivels on the grapnel rope would capsize on and hold down the preceding coil of the rope on the drum, unless the four coils were all kept very wide apart.

As the strains to which it was expected the machine might probably be put were very great, it was thought advisable not to take the power through the shafts of the drums, B, B; and accordingly the drums had spur wheels, D, D, fixed at each side, into which the pinions, E, E, geared; and by this means no torsional strain whatever was put on the shafts of the drums. The strain of the grapnel rope was divided thus between four spur wheels, and the pitch of these was only 4 inches; although in the paying-out machine, where this division of strain could not be effected, the spur wheels were 5 inches pitch. Each of the drums had a break, F, fixed to it, and both the breaks were worked by one shaft, G, G, with two screws on it, carried fore and aft along the machine over the breaks. All the strain of the breaks was carried by brackets, H, H, on the sole plate, and in no way by the screw shaft, G; and this is believed to be rather a novel application of the break strap, and may be worthy of remark.

The machine was driven by a pair of trunk engines, precisely duplicates of the pair employed in the paying-out machine; and these engines, together with the picking-up machine itself, were made by Messrs. Penn. There was also a system of gearing similar to that belonging to the paying-out machine, for admitting of a change of speed and power; the slowest speed, when the engines made 80 revolutions per minute, was about $\frac{3}{4}$ knot per hour, and the quickest about $1\frac{1}{2}$ knot per hour. The machine was supplied with a draw-off wheel, I, and jockey wheel, J, having an adjustable weight, K, so as to keep the grapnel rope, A, well taut on the drums, B; and a rotometer was added for measuring the length of grapnel rope overboard. When the picking up of the cable was in progress, the grapnel rope was delivered from the picking-up drums into the fore tank, which was at that time empty.

(*To be continued.*)

MONTHLY NOTES.

Passenger Communication on Railways.—An experiment of great interest and importance to the public was recently tried on the North Eastern Railway, in connection with the means of communication by passengers on railways with the driver or guard of the train in which they may be travelling. One objection to the cord and gong employed on some lines is that, while it answers all the purposes required as between guard and engine driver, it is defective as regards the passengers; because the cord is extremely difficult of access, inasmuch as it necessitates the opening of the carriage door, and the person lying lengthways on the floor of the compartment, in order to get hold of it. It is also very difficult to apply, even after it has been reached, in consequence of the necessarily great friction. Besides, the cord sometimes becomes entangled, and often broken. Hence the necessity for an improved apparatus. Now there are only two means of communication, namely, the cord system and electricity. In the interval that has elapsed between the past and present parliamentary session, experiments have been made with both systems, on the North-Eastern Railway with the cord arrangement, and on the South-Eastern and London and North-Western with an electric apparatus. The experiments with electricity have been carried on with success. But it will at once strike every person that the electrical system must be open to great objection on the score of delicacy and expense. There is a continual consumption of copper, zinc, and sulphuric acid, and, besides, the apparatus is necessarily very delicate, and consequently liable to get out of order. It is subject to the constant variations that arise in the temperature of the air; and a thunder storm may at any moment render it inoperative. To add to the working cost, it must be tested at the starting of every train, in order to ascertain that it is in effective condition; and, besides, it requires that a technically educated man shall be in attendance in every train, to see that the electrical conditions and connections are perfect. A means of communication equal in efficiency with the electrical, of infinitely less cost, and, at the same time, of the greatest simplicity, has been obtained on the North-Eastern Railway, by experiments conducted under the superintendence of Mr. Harrison, the engineer-in-chief of the company. It is simply a development and improvement of the cord system; and, while it is thoroughly efficient, its simplicity is one of the greatest elements of its value. The improved arrangement is this:—A cord, carried along the top of the carriages, is attached at the engine end to the whistle of the engine, and, at the rear of the train, to an ordinary gong in the guard's van. The cord is carried along the top of the train immediately above the door of each compartment, within easy reach of the passengers' hand; and the slightest pull upon the cord will sound the engine-driver's whistle at one end of the train, and also an alarm in the guard's van at the other. At the same time, an indicator, placed outside the carriage, comes down and shows to the guard the compartment from which the signal has been given. The cord is carried along upon small pulleys; hence, there is very little friction. In the old arrangement the cord was continuous from one end of the train to the other. But in the present arrangement each carriage has its own length of cord, which is easily attached to, or detached from, the remainder, and by this means a train can be easily lengthened or shortened. There are other advantages of detail, which will readily suggest themselves to every one who has paid the slightest attention to the working of railways. The apparatus was tried on a very long and heavy market train, consisting of thirteen carriages and guards' vans; so that the cord had to be carried along an extreme length. Two of the carriages, also, had not been fitted with pulleys, so that there was nothing to carry the cord along the top of these carriages, and the friction was, consequently, greater than it would have been had the carriages been provided with pulleys. The experiment, however, was perfectly successful, the apparatus answering its purpose most efficiently. No sooner was a pull given upon the cord forward than the whistle sounded; or if the pull was directed towards the rear of the train, a white flag (the signal agreed upon) displayed at the window of the guard's van showed that the gong there had been sounded, and that the guard was upon the alert. Or, again, if the pull was even, and given in both directions, the appearance of the flag, and the sounding of the engine-driver's whistle, showed that the alarm had been given simultaneously at each end of the train. The experiment was frequently repeated, and, on the train arriving in the Central Station, the indicators were examined, and showed every compartment from which the apparatus had been used.

Captain Moncrieff's System of Mounting Guns.—The apparatus which has lately been made in the carriage department for Captain Moncrieff shows one of his methods for mounting big guns. It is strangely different in appearance from any present carriages, but it promises strange things, among which will be the possibility of cheapening fortifications to a very great extent. Captain Moncrieff's system has been long in maturing. The first idea occurred to him when watching the terrible destruction caused by a bombardment at Sebastopol in 1855. So long as an open embrasure affords a mark to lay guns upon there is no need to wait for the appearance of the piece itself. Whatever protection be placed before the gun while loading, the central and vulnerable spot must always be known, and can be attacked by artillery both by night and day. As many pieces as possible can be laid on the well-known spot and fired when the black muzzle by day or the flash by night gives token that the greatest possible damage can be inflicted on the enemy. If embrasures were not cut in the parapet the gun itself must, according to the old plan, always be visible. The men, too, must be exposed both when loading and taking aim. It has generally been believed by English artillerymen that the fire from guns mounted *en barbette* can be kept under without difficulty by shrapnell shells and riflemen. The desire of Captain Moncrieff was to invent an arrangement by which no embrasure would be necessary, no black mass raised against the sky inviting a steady fire. The experiments hitherto made have gone no farther than the 32-pounder gun. So far all have been successful. The principle is now being carried out as far as the 7-ton Woolwich gun, Captain Moncrieff having been called upon to design an apparatus which shall fire over a 10-feet parapet. We reserve detailed description for a future occasion, and express no opinion as to the success or failure of the invention. The principle is sound, but many a hitch occurs in most instances between a clever design and its successful accomplishment. The main idea is as follows:—When a gun is fired it recoils with increased force. Hitherto this force has been controlled with much trouble by setting up friction of one kind or another to check the carriage in its backward course. Hence arose great strains upon the whole system, and much wear and tear of material. The whole force of recoil was hurtful and useless, except inasmuch as it ran the gun back into position for loading. After loading it had to be pushed forward again by main force with handspikes, or in some cases, the hinder part of the carriage being lifted, trucks came into play, and the piece rolled heavily into its place. Captain Moncrieff stores up the force of recoil for future use instead of allowing it to be worse than wasted. Let us suppose that the gun is pointing over the parapet at an enemy. The lanyard is pulled strongly, the charge ignites, and as the projectile rushes forth on its errand the gun sinks out of sight into its position for loading. This movement is easy, and the recoil expends itself in raising a counterweight placed at one end of a rocker. A catch secures the apparatus in this position —gun down, counterweight raised, but the whole safely concealed behind the parapet. The loading takes place, and by a little ingenuity the piece can even be laid. When the time for firing arrives the catch is released, the cannon rises majestically above the crest of the parapet, remains just long enough to fire, and then sinks down to its loading position again. As far as the trials have gone little vibration has been experienced, so little that the inventor hopes to succeed in mounting a number of his guns and carriages upon a railway to run behind the parapet and open fire from ever-varying positions. Thus the enemy may never know the spot at which any one of them may appear next, and he cannot direct his artillery upon a known object. It is only when the gun actually appears that his doubts are set at rest, and he has not time to take aim before it has delivered its fire and again retired out of sight. If the system is successful the following chief advantages will be obtained:—1. Economy of labour, for the recoil is utilized to run the piece up again; 2, the power of masking the battery; 3, less strain, and therefore less wear and tear; 4, great economy in the construction of fortifications; 5, an incidental advantage, not originally contemplated by the inventor, is that lighter guns can be used without damage to their carriages.—*Times.*

The Recent Fall of Coloured Hail or Snow in Canada.—We have received the following interesting communication (dated March 9) on this singular phenomenon from Dr. A. T. Machattie, recently of Glasgow, but now of London, Ontario, and in his own words we present it to our readers:—"Most persons in this neighbourhood are aware that about a fortnight ago it was observed that a fall of snow or hail had taken place, of a dark colour. No one appears, however, to have made any attempt to discover the nature or cause of this phenomenon. At Sarnia the coloured snow or hail has attracted more attention. Mr. Vidal, of Sarnia, found that the dark coloured substance was *hail*, and not snow. He collected one square foot in surface of this dark-coloured hail, melted it, and found that a considerable amount of an earthy-like sediment was deposited from it, and that the water produced by melting the hail was slightly dark in colour, but contained neither salt nor sulphur, and was, as he says, 'like rain water.' Mr. Vidal gave the dark sediment to Mr. Charles Robinson of Sarnia, who kindly sent it to me for examination. After examining the substance, I think I have obtained sufficient evidence of its nature to warrant me in coming to some conclusion regarding its source; and, as I think the subject of considerable scientific interest, I hope you will give this letter a place in your columns, so that others of your readers may communicate any observations they have made, especially on the following points:—1. The date and time when the fall of hail took place. 2. The district over which it extended. 3. The direction of the wind at the time. 4. The appearance and colour of the hail or snow; and lastly, any disturbances of the barometer for some time before or after. Having given little or no attention at the time to the subject, I am in doubt regarding some of the above points, but so far as I can learn, the facts as given below are in the main correct. The fall of hail began at London between eight and nine o'clock on the night of Monday, 24th February, and was accompanied by thunder and lightning; a somewhat unusual occurrence. The wind rose suddenly, was violent, and from the east or south-east. Before morning snow had fallen, and had covered to some extent the dark hail, so that in cutting down through the snow there was no difficulty in distinguishing—1st, the upper layer of newly-fallen snow; 2nd, the layer of dark hail; and 3rd, the white snow of previous date. On placing the powder sent to me by Mr. Robinson under the microscope, I easily indentified—1st, hard, gritty, and *rounded* or *water-worn* particles of sand or some siliceous minerals; 2nd, decaying vegetable matter, in which the fibrous and cellular portions were quite distinct, and in some parts almost black, resembling *humus*, or the latter products of vegetable decomposition; and 3rd, a large number of minute living infusorial animalculæ. In short, the sediment, as far as I can judge, corresponds in every particular with the *mud* of a river or any fresh water containing vegetable matter in a state of decay. The dark colour of the water observed by Mr. Vidal is completely explained by the decaying vegetable matter, which invariably communicates a dark colour to soft water. I have heard the opinion expressed that this matter may have been discharged from some active volcano, but the presence in such large proportion of vegetable matter and living animals renders this almost, if not altogether, impossible. There are only two sources for this substance that I can think of, and these are either some muddy part of the earth's surface or muddy water. In winter in this district the only available sources of mud exposed to atmospheric influence are the great lakes, which, in stormy weather no doubt, become muddy, at least in shallow parts; and from them, during such violent gales as have been prevalent lately, muddy water might be carried into the air. With the surface of the earth frozen hard, and covered with snow, I cannot imagine mud being carried into the air from the land in Canada during winter. I have never seen the mud of any of the great lakes, but they must contain large quantities of mud in all respects similar to the sample I have, carried into them by the rivers flowing through densely wooded districts, which feed them. Lake Erie is the most likely source of this mud, since, if I am right, the wind was south-easterly, and Lake Erie is the most shallow of all the large lakes, and Lake St. Clair and the muddy flats in its vicinity must have been frozen for months. It is not impossible (though I think it highly improbable), that this mud may have come from some region far south, where the earth is not frozen on the surface or snow-covered. There are recorded instances of mud falling on ships far from land in the Atlantic, the examination of which showed it to be similar to the mud which has recently fallen here, inasmuch as it contained not only mineral matter (of which volcanic ash is usually *exclusively* composed), but vegetable matter, and, as observed by Ehrenberg, infusoria also. Unfortunately, the sudden thaw which has taken place will prevent any further examination of the dark hail, and I shall be very glad indeed if any one will communicate any further facts, or correct anything here stated regarding this recent interesting phenomenon, as it is seldom that such an opportunity presents itself for investigating an occurrence of the kind."

Patent Sliding Rudder.—Mr. Medhurst has invented a new method of fixing ships' rudders to the stern-post. The rudder itself is the one in common use, but all can be fitted on the new plan. The principle is simple and ingenious. The outer and upright part of the stern-post is slotted, and a metallic chamber formed for the insertion of a T-shaped hinge. The rudder is let down through the well at the stern from inboard, and the flange of the T hinge takes the groove till the pintle at the foot enters the heel of the post. It is then in its place, and is worked in the ordinary manner. The advantage of this invention consists in the facility presented for unshipping rudders at sea, and then hoisting them perpendicularly, and shipping them again. The difficulty experienced at sea is in getting the rudder on board to repair. Mr. Medburst overcomes this by opening a port, just above where the rudder enters the counter, large enough to admit of its being hove through by a purchase on deck. When repaired, the rudder is stept again by lowering it. The lowest hinge enters the groove and guides the others. To keep the rudder from lifting, a cap is fitted on the head and screwed to the deck, in the same way as is now done on board many Scotch clippers. On the ship striking by the stern, the force of concussion would, in all probability, drive the rudder upwards, and tear away the cap. In this lies its chief merit, for it would be the means of saving the rudders, and, in some instances, the ship also. If all the hinges and the pintle were to give way, the rudder, if not lost, would have to be hauled over the stern; but even then, the plan now about to be introduced by Mr. Medhurst would be preferable to the existing one, inasmuch as it admits of rehanging with only the labour of rigging a few spars. When a rudder is entirely carried away, there is nothing left to the crew but to manufacture a jury one. This takes time, and if the weather be stormy, more damage is done to the ship than will pay for a dozen rudders. A vessel sometimes wallows in the trough of the sea, rolls her masts overboard, and then becomes doubly disabled. When rudders can be easily shipped at sea, it would be prudent for shipmasters to carry spare ones; and if they were at hand, they could be let into their place without waiting to patch up those unshipped. To owners especially, who do not insure their ships, this invention possesses an interest; and those who do insure, and look to safety and speedy voyages, cannot be indifferent to the benefits set before them by Mr. Medhurst. The weight of metal up and down the the stern-post can hardly be so great as to exercise any appreciable influence upon a ship's pitching and 'scending qualities, for, except where the T flange bears the strain, all the other parts may be thin and light.

New Work on Sugar Refining.—Some three or four years ago we had occasion to review the first edition of Niccol's Essay on Sugar-refining. At the time we formed a high opinion of it as being the first really practical work on sugar-refining as practised on the Clyde that had up to that time appeared. Our opinion has been fully realized in a large sale of the work, and we are glad to announce that the author is producing a second edition considerably enlarged, and to be completely illustrated by copper-plate engravings.

Great Organ for Notre Dame.—The French government has ordered a very powerful organ of Messrs. Caville-Coll for the cathedral of Notre Dame, the restorations of which are just completed, and a special commission has been appointed to watch over and receive the work. The commission includes the composers Anber, Thomas, and Rossini, M. Benoist, professor of the organ at the Conservatoire, Baron Ségnier, of the Academy of Sciences, several dignitaries of the church, the director of the School of Religious Music, M. Viollet-le-Dnc, the architect, and several officials.

The Works of the late Léon Foucault.—The emperor has decided that the publication and completion of the works of the late celebrated natural philosopher shall be carried on at the cost of the civil list; a sum equal to £400 per annum is set apart for the purpose, and especially for the completion of the experiments, and the construction of apparatus projected by M. Foncault.

The Gold Discoveries in Peru.—The *Times* says that, about a year ago, the Peruvian government sent an expedition to explore the northern part of that country, on the banks of the rivers Maranow and Morona, which are tributaries of the Amazon. A steamer called *Nassor* was employed, under the command of a Major Vargas, whose official report, recently issued, is alleged to show that immense quantities of gold exist in the region through which the explorers passed. It is stated that such is the abundance that an Indian, using only a simple wooden tray for washing the gold dust, can gather several ounces of gold in two or three hours.

Monster Furnaces.—This great experiment of "monster furnaces," which has for some time been regarded with so much interest by the iron trade generally, has at length reached its consummation by "blowing in" one of the two; and, up to the time we write, it has proved itself to be a signal success. We visited Ferry Hall, to ascertain this interesting fact for ourselves, and we were amply repaid for our trouble by being permitted to enter on a full examination of this magnificent iron manufacturing establishment, which will, when all the furnaces now erected are in blast, rank among the largest works of this kind, as regards production, in the kingdom, and to reach this point it only awaits the completion of a powerful blast engine, which is in course of erection by the Lilleshall Company. The Rosedale and Ferry Hill Iron Company's establishment at Ferry Hill consists of nine blast furnaces, of which seven are about 82 feet high by 22 feet diameter, and two of 105 feet by 28 feet, blown by four powerful blast engines (when the one already referred to is completed), and fed by two efficient hydraulic hoists, by Sir W. Armstrong & Co., one balance hoist, by Head, Wrightson, & Co. Of these furnaces only five of the lesser diameter and one of the larger are at present in blast, but when the new blowing engine is completed it is said they will all be at work, and producing at least 180,000 tons of pig iron annually.—*Birmingham Daily Post.*

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

17th March, 1868.

897 R. Sims, Bedford Leigh—Horse rakes
898 R. Smith, Islington—Extracting foul air from mines
899 W. Hulse and E. Williams, Birmingham—Ornamenting of metallic bedsteads
900 C. Womersley, Saltaire—Lubricator
901 W. E. Gedge, Strand—Fuel—A com.
902 Sir J. Macneill, Charing Cross—Indicating the number of passengers and fares paid in public conveyances
903 P. M. Villamil, Eaton Square—Facilitating the ascending of gradients by locomotive engines
904 H. H. Hazard, Deptford—Revolving shutters
905 W. R. Lake, Chancery Lane—Hair stuffing.—A com.
906 J. M. Poisnel, Paris—Straps
907 J. Thomson, Camberwell Road, and J. Thomson, Camberwell Green—Shaping wood
908 J. M. Poisnel, Paris—Coverings for the feet
909 W. E. Newton, Chancery Lane—Steel and cast steel.—A com.
910 W. E. Newton, Chancery Lane—Furnaces.—A com.
911 W. E. Newton, Chancery Lane—Measuring medicine.—A com.
912 J. F. Spencer, Snnderland—Working the valves of steam engines

18th March, 1868.

913 J. M. Ure, Glasgow—Lifting the driving wheels of a locomotive off the rails
914 W. Smale, Macclesfield—Figure weaving
915 C. F. C. Cretinborne, Glasgow—Ventilating
916 W. Clarke, Gateshead, and E. Walker, Poplar—Capstans
917 E. Butterworth, Calder Cottage—Furnaces
918 W. R. Lake, Chancery Lane—Effecting economy of water in steam boilers.—A com.
919 G. Martin, Stroud—Treatment of mixed fabrics
920 A. V. Newton, Chancery Lane—Covering for floors.—A com.
921 C. J. Appleby, Southwark, and J. Riley, Caledonian Road—Cranes.
922 R. Townsend, Ball's Pond—Fire-arms
923 B. E. R. Newlands, Charlton—Treating products from spent oxide of iron
924 R. A. Wright, Homerton—Dressing millstones
925 J. B. Linnett, Birmingham—Producing optical illusions
926 G. Wailes, Stroud—Safes
927 S. Wenkheim, Regent Street—Combining a shirt and waistcoat

19th March, 1868.

928 P. Hill, Leinster Square—Breaks for perambulators
929 B Parkes, Lewisham—Crushing breeze
930 C. E. Green, Portman Square, and J. Green, Edmonton—Cartridges
931 W. R. Lake, Chancery Lane—Ventilating windows.—A com.
932 J. Edwards, Wednesbury—Supporting the roofs of coal mines
933 W. Redman. Bankfoot—Building of cop bottoms
934 E. Rowland and J. Dalton, Manchester—Closing dampers
935 G. Davies, Lincoln's Inn—Combing cotton.—A com.
936 J. E. Lane, Great Berkhampstead—Heating buildings
937 W. Richardson, Oldham—Bricks and tiles
938 F. Warner, Jewin Crescent, and H. Chopping, Roxwell—Windmills
939 W. Hooper, Mitcham—Treating india-rubber
940 J. L. Geiger, Great Winchester Street Buildings—Twisting silk
941 R. W. J. Trueman, Belfast—Removing mud
942 L. Encausse, Madrid—Application of remedial agents to the human frame
943 H. Chamberlain and J. Craven, Wakefield, and H. Wedekind, Mincing Lane—Burning bricks.—A com.
944 H. F. Shaw, West Roxbury—Machines for overcoming resistance

20th March, 1868.

945 R. Side, Southwark—Saving steam power
946 J. G. Tatters, W. Keeble, and B. Newhery, Plymouth—Cigars
947 C. Mather, Salford—Cleaning wool
948 W. Pinkney, Eggleston, and R. Calvert, Bishop Auckland—Applying jets of steam
949 R. Meldrum, Pittormie—Steam-engines
950 A. Brownlie, Wishaw—Heating air for grain kilns
951 W. Taylor, Driffield, and C. E. Taylor, Bradford—Stands
952 J Abraham and T. R. Bayliss, Birmingham—Central fire cartridges
953 J H. Cooper, Regent Street—Boots for hunting
954 C. Gunner, Kennington—Life-boats
955 J. H. C. Bade, Dalston—Ranges
956 G. Twigg, Birmingham, and H. Bateman, Barnes—Corkscrews
957 S. Duer, Harewood Square—Packing for stuffing boxes.—A com.

21st March, 1868.

958 G. Davies, Lincoln's Inn—Millstones.—A com.
959 E. D. Johnson, Wilmington Square—Pocket watches.—A com.
960 J. S. Lister, Laurence Pountney Lane—Hats.—A com.
961 G. M'Dona, Hampstead, and O. Hilliard, Dublin—Locomotion
962 W. S. Boulton, Norwich—Lawn mowers
963 J. O. Spong and J. F. Haddaway, Fulham Road—Blowpipes
964 W. G. C. Hudson, Islington—Sandal
965 H. Bessemer, Cannon Street—Refined iron
966 J. G. Jennings, Lambeth—Water-closets
967 H. Bessemer, Cannon Street—Malleable iron and steel
968 R. G. Greenhow—Breech-loading fire-arms

23rd March, 1868.

969 E. K. Dutton, Manchester—Valves
970 V. A. Deauheuf, Maindy—Compressed fuel
971 T. Pope, Twickenham—Braces.—A com.
972 W. R. Lake, Chancery Lane—Metal ties.—A com.
973 S. Holmes, High Holborn—Lamps
974 C. E. Brooman, Fleet Street—Lace.—A com.
975 H. Paulus', Paris—Pile driving engine
976 J. Brönner, Frankfort-on-the-Main—Gas burners
977 C. M'Dermot, Devereux Court—Indelible pencil
978 G. F. Guy, Bury St. Edmunds—Sugar
979 C. N. Leroy, Paris—Grease cups
980 A. W. Ramscar, Gray's Inn Road, and F. W. Wilson, Edgware Road—Breech-loading fire-arms
981 W. R. Lake, Chancery Lane—Metal ties.—A com.
982 C. De Bergue, Westminster—Locomotive engines
983 E. Vignier, Fowkes Buildings—Distilling spirits
984 A. Barclay, Kilmarnock—Barometers, thermometers, and watches
985 A. V. Newton, Chancery Lane—Thrashing machinery.—A com.
986 H. Treverton, Smithfield, and E. H. Fowler, Brixton—Frames for lamp shades

24th March, 1868.

987 J. S. Farmer, Kilburn—Transmitting signals
988 G. B. Paterson, Walworth—Gas-meter indexes
989 H. Burgess, Battle—Rails
990 W. E. Gedge, Strand—Smoke-consuming furnace.—A com.
991 W. R. Boothby, Adelaide—Rotatory motion in engines
992 T. W. Fuller, Leamington—Carriages
993 C. D. Abel, Chancery Lane—Watches.—A com.
994 E. Gray, Sheffield—Metal bars intended to be made into horse shoes
995 E. Gray, Sheffield—Rails
996 R. A. Hardcastle, Rye Hill—Iron and steel
997 J. A. Farrar and B. R. Huntley, Hartlepool—Ships' hatches
998 F. W. Crohn, Fenchurch Street—Obtaining power from a fall of water
999 D. Lewis, Liverpool—Portable tables
1000 R. Smith, Manchester—Winding cotton
1001 C. Harris, Manchester—Paper bags
1002 J. Antill, Wandsworth—Stench traps
1003 A. V. Newton, Chancery Lane—Pocket knives.—A com.
1004 R. Smith, Belper—Hulling grain
1005 M. P. W. Boulton, Tew Park, and J. Imray, Westminster Bridge Road—Aërial locomotion

25th March, 1868.

1006 R. Little, Greenock—Reducing the temperature of air in producing ice.—A com.
1007 A. Elliott, Failsworth, and J. Barker, Oldham—Lubricating axles
1008 H. A. Bonneville, Paris—Distributing circulars
1009 A. M'Glashan, Drury Lane, and J. Hendry, New North Road—Mashing substances
1010 A. B. Wollaston, Chiselhurst, and F. Stanbridge, Llangarron—Treatment of mixed fabrics
1011 J. Warburton, Sandal—Steam-engines
1012 G. Hayhurst, Bury—Drying cylinders
1013 W. Buck, Upper Tooting—Working railway points
1014 T. Lane, Birmingham—Looms
1015 C. E. Brooman, Fleet Street—Paper tubes.—A com.
1016 S. Fisher, Strand—Ornamenting tiles
1017 J. Plant, Sheffield—Dram flasks
1018 A. V. Newton, Chancery Lane—Spinning.—A com.
1019 W. Richardson, Oldham—Cleaning wool
1020 T. Whitehouse, Wednesbury—Blast furnaces
1021 T. Sagar, T. Richmond, and C. Catlow, Burnley—Looms
1022 J. Anderson, Ramshottom—Carding wool

1023 J. Jameson, Gateshead—Safety paper
1024 The Hon. H. G. P. Meade, Belgrave Square—Fire-arms
1025 A. P. Price, Lincoln's Inn Fields—Treatment of ores
1026 W. P. Piggot, Argyle Street—Transmitting electric telegraph messages

26*th March*, 1868.

1027 E. J. J. Dixon, Bangor—Smoothing slate
1028 J. T. King, Liverpool—Dressing millstones
1029 W. Oram, Salford—Hydraulic presses
1030 M. B. Orr, Glasgow—Preserving animal substances.—A com.
1031 W. H. S. Aubin, Wolverhampton—Cocks for drawing off liquids
1032 T. Bettney, Manchester—Paper-cutting machine
1033 H. Davey, Westminster—Steam-engines
1034 W. Clark, Dunfermline, and J. Clark, Paddington—Locomotive engines
1035 M. Havenhand and J. Allen, Dronfield—Pistons
1036 J. Cocks, Regent Street—Making of trousers
1037 W. Manwaring, Banbury—Reaping machines
1038 W. D. Cliff, Wortley—Furnaces
1039 W. S. Page and R. East, Nine Elms—Steam-boilers
1040 B. Browne, King William Street—Collars.—A com.
1041 S. Perry, Red Lion Square, and F. Brampton, Birmingham—Letter clips
1042 J. Lyall, New York—Looms
1043 J. H. Johnston, Lincoln's Inn Fields—Lamps
1044 T. Routledge, Sunderland, and W. H. Richardson, Jarrow-on-Tyne—Bleaching esparto

27*th March*, 1868.

1045 A. Warner, Lsurence Pountney Lane—Cement
1046 S. Holman, Laurence Pountney Lane—Steam pumps
1047 J. Bates and J. Taylor, Dukinfield—Cleaning the flues of boilers
1048 A. Scott, Paddington—Production of drinks
1049 J. Manrice, Lsngham Place—Producing optical illusions
1050 F. Bauman, Strand—Treatment of wood
1051 G. Hodgkinson, Manchester—Producing patterns upon woven fabrics
1052 G. Davis, Lincoln's Inn—Steam-engines.—A com.
1053 P. Adie, Pall Mall—Shearing sheep
1054 C. E. Brooman, Fleet Street—Breech-loading fire-arms
1055 C. B. James, Redditch—Wrapping up needles
1056 W. E. Newton, Chancery Lane—Engines.—A com.
1057 H. Jones, Soho Square, and W. T. De La Rue, Bunhill Row—Whist counters
1058 J. G. Jones, Newport—Hauling minerals in mines
1059 W. W. Hughes, Porchester Terrace—Propelling vessels
1060 S. C. Lister, Manningham—Cut pile fabrics
1061 H. Hughes, Bristol, and C. Jones, Wolverhampton—Locks and keys
1062 J. G. Fildes, Elton Bury—Bearer for conveying ladles containing molten metal

28*th March*, 1868.

1063 T. C. Currie, Kensington.—Preserving milk
1064 H. G. Warren and S. Stuckey, Deptford, and P. Froud, Greenwich—Revolving iron shutters
1065 J. Macintosh, Regent's Park, and W. Boggett, Chelsea—Boots and shoes
1066 C. Joyner, Birminghsm—Water slide gaseliers
1067 J. C. Coombe, Hollowsy, and J. Poole, Chelsea—Coating iron
1068 W. J. Addis, Tanna—Permanent way of railways
1069 W. E. Gedge, Strand—Moistening postage stamps.—A com.
1070 W. R. Lske, Chancery Lane—Filters.—A com.

30*th March*, 1868.

1071 H. Armstrong, Tow Law—Steel
1072 O. Ormrod, Eagley—Bleaching yarns
1073 C. F. Claus, Middlesborough-on-Tees—Iron
1074 C. F. Clans, Middlesborough-on-Tees—Malleable iron
1075 B. Mitford, Cheltenham—Communicating with deaf and dumb
1076 J. H. Johnson, Lincoln's Inn Fields—Cast steel.—A com.
1077 J. H. Johnson, Lincoln's Inn Fields—Cork.—A com.
1078 J. H. Johnson, Lincoln's Inn Fields—Cast steel.—A com.
1079 J. F. Hadland, Birmingham—Metal ties.—A com.
1080 F. Wirth, Frankfort-on-the-Maine—Stopping the progress of railway trains.—A com.
1081 J. M. Day, Southwark—Decorticated seeds
1082 A. B. Walkor, Warrington—Hot blast air
1083 C. S. Tyson, Maryland—Taking up the recoil of heavy ordnance
1084 J. Walker and J. Wharrie, Glasgow—Cast-iron pipes
1085 J. Jordan, Liverpool—Fire-bars

31*st March*, 1868.

1086 W. Austin, Hatton Garden—Composition for obtaining instantaneous light
1087 F. Taylor, Carey Street—Fittings for railway carriages
1088 W. Allen, Manchester—Diminishing valves
1089 J. Sinclair, Stirling—Screw propellers
1090 M. Hawthornthwaite and T. Abbott, Lancaster—Taps
1091 H. B. Woodcock, Low Moor—Metal axles
1092 J. Lent, Berlin—Express telegraph
1093 L. F. P. Riviere, Mark Lane—Velocipede
1094 J. H. Weston, Kennington Road—Lighting the interior of buildings
1095 H. Bessemer, Cannon Street—Malleable iron
1096 J. H. Johnson, Lincoln's Inn Fields—Sewing machines.—A com.

1*st April*, 1868.

1097 T. Couldrey, Kirkdale—Making pumps
1098 H. H. Doty, Bury Street, and G. Graveley, Bow—Burners and Lamps
1099 A. Scatchard, Mile End—Aërated bread
1100 A. M'N. and M. A. Wier, Bayswater—Pneumatic apparatus
1101 W. A. W. Sleigh, Bayswater, and A. Pye, Paris—Protecting trousers from mud
1102 W. Smith, Glasgow—Pig iron
1103 L. Appleton, Regent's Park—Calculating interest by a rapid arrangement of figures
1104 G. Davies, Lincoln's Inn—Centrifugal ventilators.—A com.
1105 J. Norris and T. Qarm, Bloomsbury—Cooking apparatus
1106 J. Walker and J. Candlin, Wolverhampton—Flooring sash
1107 G. Kynoch and W. Whitehill, Birmingham—Cartridges
1108 W. Clissold, Stroud—Belt fastenings
1109 R. J. Morison, Bishopgate Street—Cotton gins
1110 W. R. Lake, Chancery Lane—Horse shoe nails
1111 J. H. Dufort and D. Gance, Paris—Sewing machines

2*nd April*, 1868.

1112 J. Saxby, Kilburn—Locking railway points
1113 E. Leaky, Euston Square—Movable railway
1114 T. Baker, Stratford—Umbrellas
1115 A. Jackson and J. Hartley, Manchester—Braiding machines
1116 H. Lafone and J. Nicholas, Liverpool—Furnaces for burning petroleum
1117 J. G. Dale and E. Milner—Producing white pigments from lead
1118 W. Robertson, Glasgow—Shaping timber
1119 J. Napier, Glasgow—Steering ships
1120 W. E. Boardman, Paris—Steam packing.—A com.

3*rd April*, 1868.

1121 J. & T. Walmsley, Little Harwood—Warping yarns
1122 A. De Metz, Wolverhampton—Water closets
1123 J. S. Crosland, Manchester—Steam-engines
1124 C. D. Abel, Chancery Lane—Refining camphor.—A com.
1125 J. Wallace, Glasgow—Digging potatoes
1126 J. M'Culloch, Shawlands—Utilizing waste tarpaulin
1127 J. Harwood, Blackburn—Sewing machines
1128 C. W. Baldwin, Boston—Measuring the amount of a flowing liquid
1129 A. Martin, Clothfair—Bonnet shapes
1130 J. H. Johnson, Lincoln's Inn Fields—Cast steel.—A com.
1131 J. V. Jones and G. J. Williams, Birmingham—Ornamenting metallic tubes
1132 G. Piggott, Birmingham—Electric telegraphs
1133 W. Williams, Tividale—Tin plates
1134 J. G. Tongue, Chancery Lane—Lamps.—A com.
1135 T. Row, Bow, and S. Scott, Chelsea—Paper hangings

4*th April*, 1868.

1136 H. C. Butcher, Strand—Tobacco pipe
1137 H. Cochrane, Longlands—Blast furnaces
1138 W. Johnson, Kensington—Moulding coal
1139 T. A. Calvert, Manchester—Cleaning cotton
1140 T. Faucheux, Caversham Road—Axles of wheels
1141 A. & H. Illingworth, Bradford—Folding worsted
1142 F. A. E. G. De Massas, Hoxton—Cleaning cotton
1143 F. H. Greenstreet, Wolverhampton—Targets
1144 R. Nslbs, Kentish Town Road—Locks
1145 C. E. Turnbull, Camden Square—Paperbinders
1146 G. Davies, Lincoln's Inn—Washing ores.—A com.
1147 D. Campbell, Asknish—Propelling ships
1148 J. Griffiths, Chesterfield, and J. Jeavons, Sheffield—Piles of iron

6*th April*, 1868.

1149 H. & J. Bryceson and J. H. Morten, Euston Road—Organs
1150 D. Crichton, W. Donbavand, and D. Crighton, Manchester.—Looms
1151 E. Hay, Lombard Street—Measuring the flow of liquids.—A com.
1152 J. Dunbar, Camberwell, and R. Nicholson, Dulwich—Inserting coal
1153 R. Moreland and D. Thomson, Saint Luke's—Pumping engines
1154 C. H. Gardner, West Harding Street, and J. Bickerton, Oldham—Lithographic printing machines
1155 M. A. F. Mennons, Paris—Transmission of typographic telegrams
1156 J. M. Plessner, Psris—Obtaining motive power
1157 J. Radcliffe, Consett Iron Works—Iron and steel
1158 J. Perry, Rathdowney Brewery—Packing bottles
1159 C. Desnos, Paris—Permanent way of railways
1160 T. Holt and H. Spencer, Rochdale—Spinning
1161 A. V. Newton, Chancery Lane—Bathing shoes.—A com.
1162 A. V. Newton, Chancery Lane—Anchors.—A com.
1163 J. Casson, Sheffield—Planing wood

7*th April*, 1868.

1164 E. Watteeu, Vulcan Works—Screw taps
1165 R. Holliday, Poplar—Preventing accidents.
1166 H. J. Ditmars, Pancras Lane—Consuming smoke.—A com.
1167 A. L. Holley, Harrisburgh—Iron and steel
1168 W. Nsll, Leicester—Igniting matches
1169 E. H Newby, King William Street—Boat-detaching apparatus
1170 H. Fisher, Sheffield—Handles of tea pots
1171 F. Simpson and S. Hardwick, Handsworth—Rolling sheets of iron
1172 C. W. Siemens, Westminster—Gas furnaces
1173 J. Sherwood, Birmingham—Lamps
1174 R. G. Lowndes, Auldhousefield—Finishing textile fabrics
1175 J. Armstrong, Clifton—Harrows
1176 P. M'Mahon, Temple—Preventing decay of animal substances
1177 D. Lsne, Cork—Floor cloth

8*th April*, 1868.

1178 C. G. Spencer, St. Luke's—Flying apparatus
1179 J. Bedford, Leeds—Drying grain
1180 J. J. Chandun and J. J. Dexant, Paris—Breech-loading fire-arms
1181 J. James, Ebbw Vale, and T. Jones, Govilon—Iron
1182 G. H. Palmer, Lewisham
1183 W. R. Lake, Chancery Lane—Cutting rocks.—A com.
1184 W. E. Newton, Chancery Lane—Salts of soda
1185 E Benningfield, Old Kent Road—Lifting machine
1186 C. G. Hill, Nottingham—Fringes
1187 V. Gallet, Lavausseau-de-Benassais—Steel
1188 E. Brasier, New Cross, and J. E. Hodgkin, Liverpool—Preparing flax
1189 S. Hunt, New Road—Ordnance
1190 C. Douglas, Edinburgh—Cutting teeth of wheels

9*th April*, 1868.

1191 W. Chapman, Kennington Park Road—Skiving or chamfering leather
1192 J. Fitter, Birmingham—Alarums
1193 J. Plews, Hounslow—Steam-engines
1194 J. Rae, Sydenham, and G. Miller, Glasgow—Railway wheels
1195 A. H. Still and D. Lane, Cork—Gas
1196 W. B. Robins, Oxford Street—Garden engines
1197 J. H. Whitehead, Manchester—Removing soot from heating tubes
1198 G. T. Bousfield, Brixton—Cutting dies.—A com.
1199 J. Leeming, Bradford—Looms
1200 W. E. Newton, Chancery Lane—Fire-arms.—A com.
1201 R. A. Wright, Homerton—Burning petroleum
1202 L. Verstraet, Paris—Burning petroleum

11*th April*, 1868.

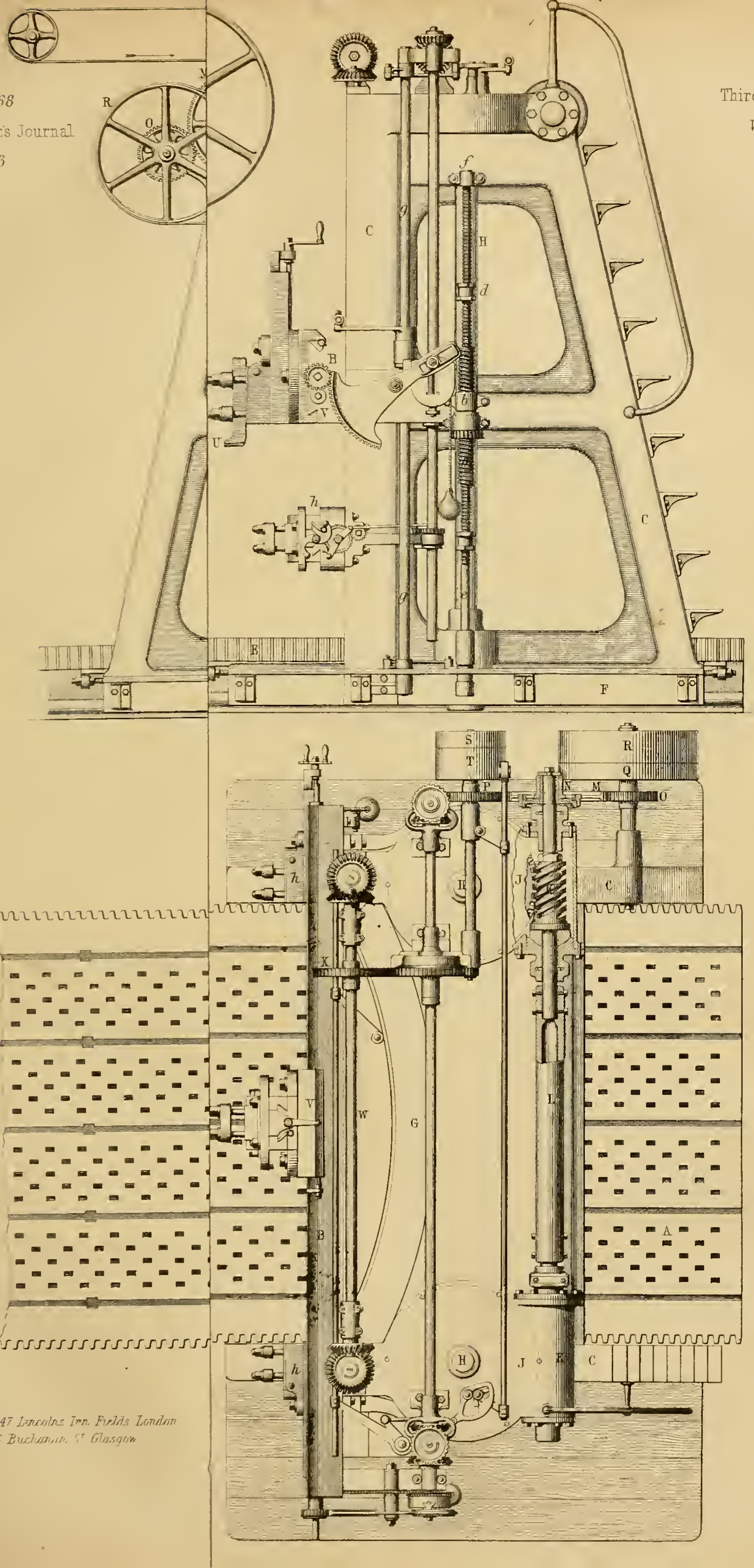
1203 J. Sutcliffe, Bradford—Outline maps
1204 J. Marsden, Bolton—Beams or girders
1205 C. Martin, Chancery Lane, and W. Barrett and T. S. Webb, Norton—Titaniferous iron ores
1206 C. E. Brooman, Chancery Lane—Photography.—A com.
1207 T. H. Baylis, St. John's Wood—Cribs
1208 J. C. Wilson, Lime Street—Hydraulic packing presses
1209 R. Nicholls, Aldermanbury—Self-attaching buttons
1210 G. Clark, Strand—Explosive compounds
1211 H. A. Archereau—Obtaining heat and light
1212 S. W. Huntington, Augusta—Preparing paper
1213 A. Woodcock, Edinburgh—Suspending pictures
1214 M. A. F. Mennons, Paris—Preparing effervescent beverages
1215 E. Dubois and E. Casper, Cannon Street—Wet gas meters
1216 A. Barclay, Kilmarnock—Condensing steam-engines
1217 G. Paton, Kilbirnie—Looms

13*th April*, 1868.

1218 B. J. B. Mills, Southampton Buildings—Bleaching feathers.—A com.
1219 J. Rothery, Leeds—Getting and hewing coal
1220 R. Ridley, Birmingham, and J. Rothery, Leeds—Getting and hewing coal
1221 F. F. Shillington—Reaping and mowing machines
1222 T. Forster, Streatham—Compounds of india-rubber
1223 G. E. Donisthorpe, Leeds—Getting coal
1224 E. Richardson, Falcon Square—Stays
1225 J. Combe, Belfast—Breaking flax

June 1868
Practical Mechanic's Journal
Plate 3

Third Series
Vol. 4.



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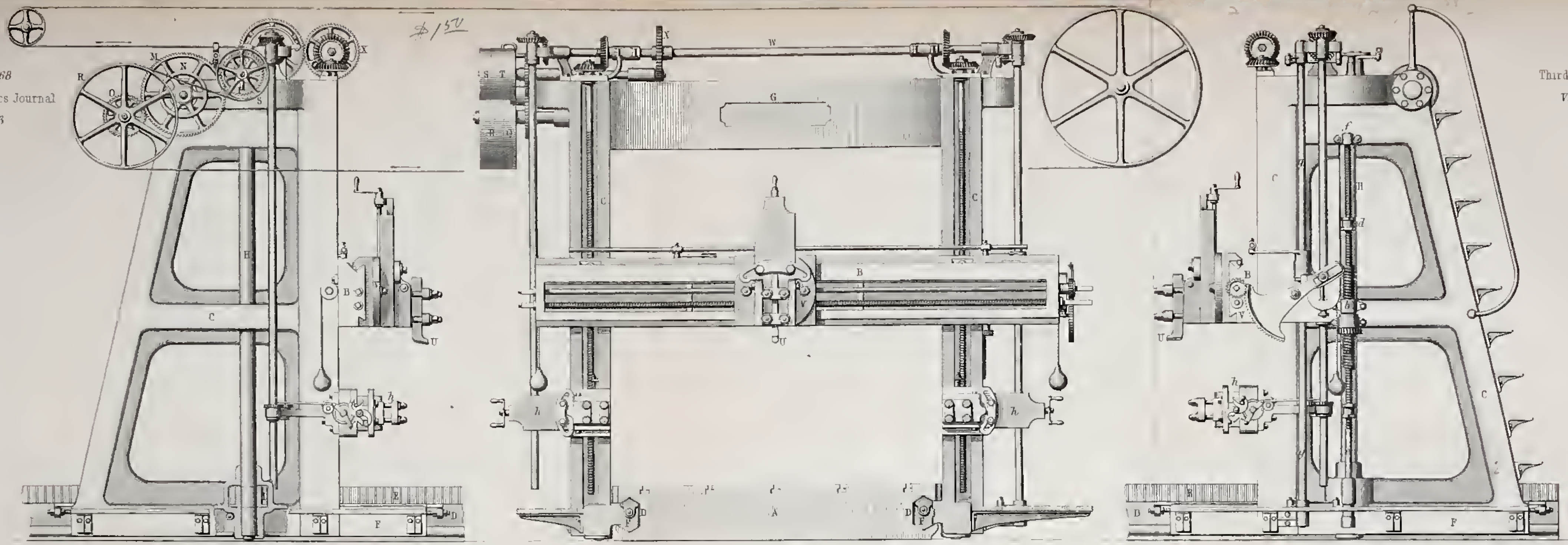
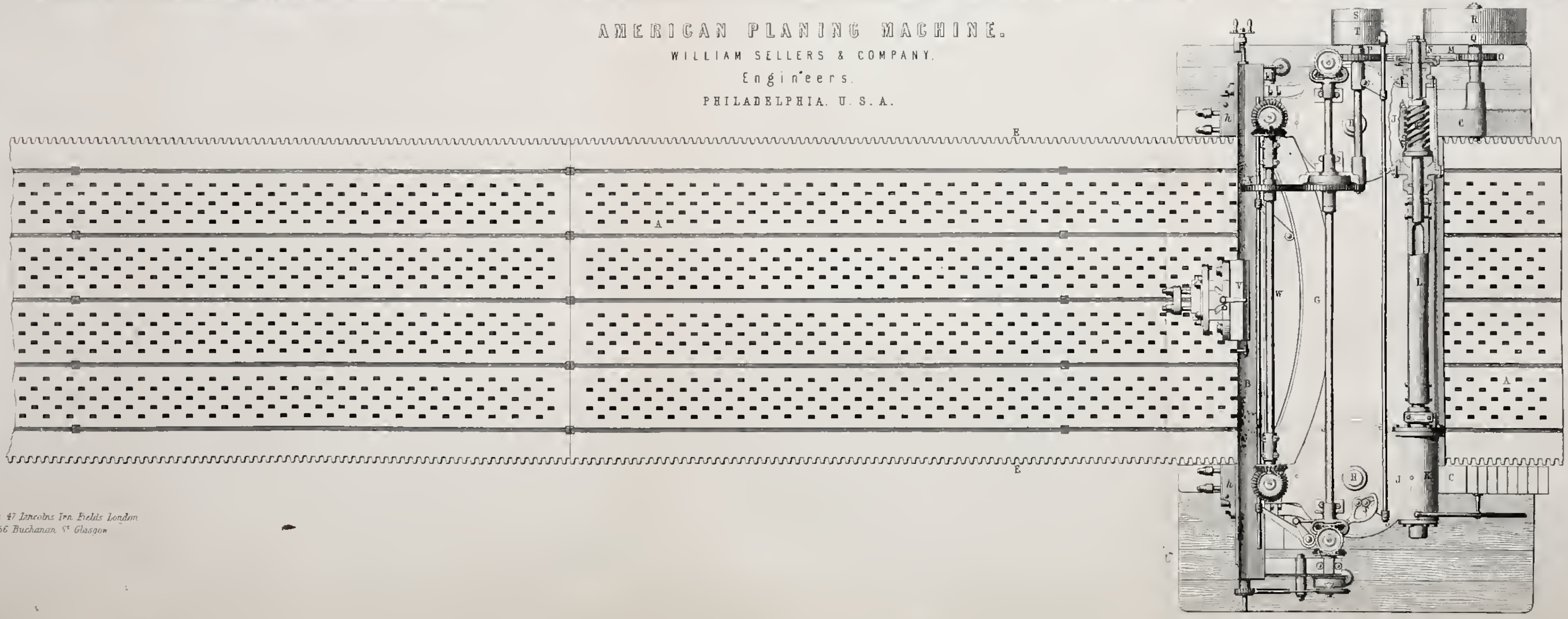


AMERICAN PLANING MACHINE.

WILLIAM SELLERS & COMPANY.
Engineers.
PHILADELPHIA. U. S. A.



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and 166 Buchanan St. Glasgow

THE FUTURE OF STEEL: ITS EMPLOYMENT AND WORKING.

THE saw of an ancient priesthood—"Behold the old paths, walk ye in them"—expressed not alone the twilight narrowness of a creed, but indicated a prejudice which is, as it were, instinctive in mankind. While everything flows on and changes, whether we will or no—even heaven-descended theologies and creeds—men with repugnance cast away the old and accustomed for the new and little tried, even where the old has no preternatural sanction supposed to attach to it, and where the reasons in favour of the new are decisive. With the mass of men, ay, even of inventors and foremost men of whom Carlyle profanely predicates "the heaver intellect," constructors in all varieties, it is a wrench to leave the old paths and walk suddenly in the new. The recent history of steel and its uses is a somewhat remarkable case in point.

Fifteen years ago, when steel was practically unknown to us in Great Britain at a price under some £60 per ton, and when even in Austria the Styrian puddled steel though known, and known at a far lower price, and in Western Prussia steel of the same sort, remelted, was in large production, yet steel for large structural purposes was but timidly suggested—as for suspension bridge links, by the Chevalier von Mitis—while it was readily employed in Great Britain by the mechanical engineer for a few small pet purposes, and with a sigh that its high price precluded its being more largely employed. Germany was long and largely before us, however, in the use of steel for purposes requiring a larger scale of supply, chiefly because that supply was met by the production of puddled steel; when Bessemer's great discovery at one blow attracted universal attention to the subject of steel, and suggested the prospect of a not distant future in which steel in price, weight for weight, should compete with that of wrought iron.

The day of steel had dawned, and the interest excited in the metallurgic world was sufficient ere long to introduce several other competitive or subordinate methods of manufacture upon the grand scale, as well as that of Bessemer. The Mersey Steel Company began the manufacture of puddled steel under what is known as Riepes' process, and were, we believe, the first to introduce it into Great Britain. In addition, and subsequent to these dates, the processes of MM. Martin, M. Berard, of Mr. C. Siemens, and some others, have supplemented the two great methods—those of puddling and that of Bessemer—upon which the steel supply of the future possibly may mainly rest. Not but that we think Mr. Siemens' simple and effective method of steel-making, by merely fusing wrought iron and cast iron together in one of his gas furnaces, suitably worked, as capable of almost indefinite extension; and should his project of making steel in properly modified gas furnaces directly from hæmatite ores prove in the end successful, that method cannot but prove a formidable competitor to both Bessemerizing and puddling, and be the means of introducing steel manufacture into many districts of the world where hæmatite is abundant, but fuel not good in quality, where otherwise it must remain excluded.

Already the cost of steel has been brought down to about double that of wrought iron, and as, on the average, it is structurally of about twice the strength of wrought iron (writing roughly), so probably the steelmakers think they may with a clear conscience pocket the very handsome profit they make at existing prices. But the Bessemer patent draws to a close, and Bessemer works, already extending in many directions, are certain to take a new start from the day when the state shall declare that he has had his reward, and that patent monopoly or claim is no more.

Already, and for a good while past, there is no financial reason why steel should not have become largely and widely substituted for wrought and cast iron. There will be still less when the manufacture by Bessemer's method shall be free, and no doubt, as we long ago predicted in the pages of this journal, the time will come when wrought iron will be a curiosity, at any rate its employment for structural or mechanical uses the exception and not the rule. But in the interim steel and its uses are new, and the old desire of a large fraction of men to "set their faces as a flint" against that which is a departure from the old ways is apparent enough.

Most of the iron shipbuilders and iron bridge constructors with reputations, and whose opinions are supposed to sway technical assemblies, say a great many complimentary things of steel, but upon the whole they rather object to use it, or to pledge their sacred reputations to the result if it be used. The usual formula of difficulty, rather than of objection, shapes itself something in this way:—We have been amazed, &c., at the prodigious resistances of the new material; we are most anxious to employ it and to give our customers, &c., &c., the benefit of the vast saving in weight and increased strength of which it admits, and we hope that the steel manufacturers will enable us hereafter to do so, by insuring to us a more complete uniformity of production as regards the quality of their steel than they have hitherto done; but until this has been achieved we dare not employ or recommend it, &c., &c., &c.

Now there is just enough of reality and truth in all this to prevent a highly respectable and responsible individual of the class of our Samudas, Russells, or Fairbairns (as to whom we do not intend to hint even anything of disrespect) from being laughed at, when it is gravely and *ore rotundo* uttered in public, as in very fact just such words were at the last meeting of the Institution of Naval Architects. But there is much more in it of the mere longing to keep to the old paths because they *are* old, well beaten and smooth, and easily gone upon, than of real weighty objection upon which to found a just postponement of departure from them and undertaking the rough ways of the new ones.

Let us examine with a little insight, then, what is the weight and extent of the real objections or difficulties that can be alleged against the structural use of steel at this moment, for we do not for a moment deny that there are such objections; this being one of the cases in which, unless we ask and answer the question, "How much?" we shall get at very little useful light by merely ascertaining that the quality of the objection is such or such.

The constructional revolution from wrought iron to wrought steel (leaving out of view for the present altogether the closely concerned but distinct question of that from cast iron to cast steel) is, then, really beset at present by three clearly definable difficulties, which, in proportion to their reality or extent, do seriously, or may, affect the reputation and the pockets of the manufacturer and the results he hopes to produce for his customer.

First, it is a fact that amongst almost any large lot of rolled steel plates, angle, T-steel, &c., testing at random proves considerable differences of tensile strength in the material.

"If," says the iron shipbuilder, "I am to economize weight in my ship, and give the value of the saving of that in cargo-carrying power to my customer, by employing a material the safe tensile coefficient of which is to be taken at 20 or even 30 tons per square inch, then I must be sure beforehand that every plate delivered to me by the plate maker shall be equal to that; and as the weakness of one part of my ship may be the weakness of the whole, I can get for myself or my customer no better value out of this steel with safety than that which the coefficient of the weakest plate I find in the whole shall warrant." That is quite true in principle; and it is quite true in fact, that in any large lot of rolled steel plates or the like, which have been rolled direct from reheated billets made from puddled balls of steel, more or less of such difference does and must occur.

But let us ask, Are such differences quite unknown amongst plates of the old-fashioned wrought iron? Is it true that in any large lot of boiler plate delivered for ship or bridge building every plate can be implicitly trusted to the coefficient of ultimate strength that shall make all quite safe on the Board of Trade conditions, supposing these were ever put to the real test? On the contrary, is it not perfectly well known that the difference of ultimate cohesion—to say nothing of degree of elongation—to be found amongst plates of the same make and of the same lot are often considerable? that with certain makes of *rigid* wrought iron, which is really preferred by many for certain parts of ship and bridge structures, departures are to be found in occasional plates from the mean coefficient of strength, very nearly, if not altogether, as great as those which have given a bad name to steel? We have ourselves found single plates in a large lot of a rigid make of iron deficient in strength to the extent of from 10 to 12 per cent. below the mean, and with a still larger reduction in elongation, *i.e.*, a still greater want of toughness. Yet, do we walk in fear and trembling in designing and fixing scantlings for wrought-iron structures for this reason? No; for we have lost sight of the fact, because by the constant use of suitable precautions in the reception of the iron, and in the use of a very ample coefficient or margin of safety, we have come to regard it as not worthy of serious anxiety. Then why should it be one with steel, if only we adopt the right methods in dealing with the new material? Some of these are obvious enough. The roller of steel plates should, under written instrument, guarantee to his customer, the ship or bridge builder, a certain minimum coefficient of tensile strength; the latter being at liberty to test any plate upon reception, and if any one plate prove defective, to reject the whole at the expense of the maker. Let the steel manufacturer charge a fair price to cover this condition (he has a pretty good profit at present, it would seem, to cut upon), and to insure his being able to carry out his transactions without unusual risk. If he rolls his plates from puddled steel billets, or from small ingots of Bessemer steel, let him provide an officer and the proper means to test rapidly but decisively the breaking tension of a piece of one plate from each such billet or ingot, stamp with a distinguishing mark every plate made, and record the tests. The residual chance of the untested plates out of each billet or ingot differing materially from that proved is not worth consideration, always supposing that every step of the process of manufacture up to the passing the finished, squared, and *cold* plates out of the rolling mill gate, has been conducted without carelessness.

The steel manufacturer may think this is putting an unwarrantable strain of responsibility upon *him*; but if he is determined to accelerate and render complete within his own generation the revolution from iron to steel, such is, in our humble judgment, the way, and the only way, to do it. Take out of the shipbuilder's mouth the plausible objection of want of uniformity, and the shipowning world will soon compel the change to ships of steel to be universal.

But this onerous method of guaranteeing uniformity which we have sketched would have no terrors at all, and in fact would become ultimately a mere routine or form, if the steel manufacture be conducted as it might, and as, we take leave to say, it ought to be. The want of uniformity complained of, so far as it is real, actually comes from the plates being rolled from distinct ingots or billets—which themselves are not alike—some of which are of one class of steel, some of another. Why should that method be continued? Five or six years ago, even at the conclusion of the experiments in France of M. Sudré, of which we gave an account in this journal, there remained no doubt of the possibility of melting large masses of steel in reverberatory furnaces without alteration in the qualities of the metal, and of thus melting together a great number of ingots, and re-casting these into ingots, all of which, as from the very same liquid bath, must of necessity prove homogeneous. M. Sudré's process, however, was expensive, and his furnaces did not last long. Since that time, however, Mr. Siemens has fully demonstrated at Birmingham the facility with which he can melt together an almost unlimited quantity of steel ingots, whether obtained by Bessemerizing or by puddling, by means of his gas furnaces, and then re-pouring them into ingot moulds, when, by mixture, the material of the whole has been made alike.

Mr. Siemens has also proved, and in our judgment beyond reach of doubt, that the continuance of the steel in his furnace in fusion for two or three hours can be made greatly to *improve* its quality, in place of in the slightest degree deteriorating that; and he has shown that from the wonderful versatility (so to say) of his furnace giving him the power of maintaining the bath of liquid steel under a reducing, a neutral, or an oxidizing flame, he can work almost any metallurgic change in the quality of the steel he pleases.

Here then is, as it seems to us, at a blow, the chief remedy for all the complaints of want of uniformity. Melt a second time the partial products of the first process, the billets or the ingots, into great masses, take samples from the liquid bath, pour into new and perfectly alike ingots again, and hammer and roll from these.

It is but to do upon a great scale what Krupp and the Bochum Company do in effect, by remelting their steel bars or ingots in 60 lb. crucibles, and pouring scores of these into one ingot; and it is due to this remelting that their steel plates and other forms have justly acquired their superior reputation for uniformity and trustworthiness. But this alone is not enough. If uniformity of final result is to be assured, we must not only have, as above, secured uniformity in *the chemical constitution of all the lumps* from which the plates are to be rolled, or the bars, or whatsoever other form, but we must adopt such mechanical operations throughout the remainder of the progress of these lumps into plates, &c., as shall finally leave *the material in the all in the same molecular state.*

Now, as this molecular condition is modified by every step of manufacture, by every heating and cooling, by every forced change of form, whether by hammering or rolling, &c.; so must all these steps be rigidly alike in kind and in number upon all the lumps, in order that, in the end, the plates of the same size and thickness made from them shall be all alike in quality.

It won't do to work the same lot of plates, as is now commonly done, out of three or four different sizes of ingots, or puddle balls or billets. The same lot of plates, in order to be in the end molecularly alike, must be all produced from the same size and form of lumps, and these must be submitted, as nearly as possible, to the same number of heatings, and to the same sort of hammerings and rollings. It won't do that one ingot or billet should be made twice as hot as another, and that because it is then soft, the roller should pass it through the rolls, missing every second size in these. The three efficient causes (apart from chemical ones) which determine the final molecular constitution of the steel plate of a given size—made originally from one ingot of a given size—and which being the same, shall leave all other like plates made from like ingots identical with it, are, *number of times and intensity of being heated; rapidity, more or less, with which it has been each time cooled* (upon which those partial internal strains due to contraction of the external *couches* depend, which modify crystalline arrangement); and *number of times, direction, and intensity with which the form and dimensions have been altered by blows or mechanical pressure while the mass is soft and hot.* Unless all these be rigidly the same for all the ingots and all the plates to be made out of them, the latter cannot be precisely alike in quality, though they all came from steel chemically the same, from one block in fact. This is equally true of wrought iron, though not to the same extent, from the greater ductility of that metal, and from other reasons. In wrought iron, however, it can be afforded to be neglected; not so in steel.

These are pretty obvious metallurgic truths to any one who has really grasped the laws of the crystallometric constitution, not of steel alone, but of all metals, and combined these with the known properties special to steel; but yet we are not aware that they have ever before been distinctly enunciated, nor can they be gathered from the statements of any British author on metallurgy, and certainly they have not so far been in any understanding spirit acted upon by our British steel manufacturers.

But over and above all the metallic properties which steel possesses, common to it and to other metals more or less, is that marvellous and instantaneous change of molecular arrangement by which it is *hardened*, when from a high temperature it is more or less suddenly cooled. Whilesoever, then, the entire extent of care bestowed by the steel roller upon the final destination of each of his plates after it has passed for the last time through the rolls, is, that it is thrown down somewhere upon the iron-plated or sandy floor of the rolling-mill to cool as it may and how it may, how is it possible that any two plates, even of the same size and thickness, shall go out of the shop certainly alike? One plate while red hot is thrown direct upon the sand floor, possibly even upon the iron plates, or kept up partially off these by a couple of bars on the floor. The next is thrown on that, and so on, until a heap is formed, which accumulates in all sorts and intensities of drafts of air, and sometimes even of drifting rain. The lower plates *may* be much harder, the middle ones may be a good deal softer, and the last upon the heap something harder again than any of them might be, were all cooled as they should be cooled, slowly and alike.

Why should not the steel-plate manufacturer take to his bosom the very same methods which the glass manufacturer has been compelled to adopt by the very nature of *his* material; put up proper annealing ovens, run his steel plates on edge direct from the final turn of the rolls, and before the edges have been shorn, into such an annealing oven, and there let them abide for such a time as experience should show requisite, slowly cooling down to atmospheric temperature, so that in the end the steel of all should be alike, and all in the softest possible condition? The cost would be almost nothing. A Siemens' gas furnace, with a few tons per week of the most refuse fuel (the gases being first freed from sulphur), would heat a long vaulted annealing oven for an almost nominal cost, at one end of which the steel plates should continually enter, and be kept as hot nearly as they would stand up on edge stiff; while at the other they should be withdrawn not hotter probably than boiling water.

Possibly hot blast, heated by waste furnace heat, might prove still more economical; but we should fear by that method some scaling or oxidation of the plates, which may be completely avoided in the neutral flame of the gas furnace. Hot blast might be had as hot, perhaps, as 900° or

1000° Fahr., but we entertain great doubts that even that maximum temperature would prove at all sufficient for perfect and complete annealing of steel plates.

The proposition to anneal steel plates by means of a bath of melted lead has been spoken of, and, if we mistake not, advocated by Mr. Roehussen. That *any* subsequent heating of a hardened steel plate must have some *tendency* to soften it, or to "bring down its hardness," as the spring temperer calls it, we shall not deny; but that any sufficient annealing—to be of real value at all, still more to bring the more or less hardened steel plates all to their softest and best state—is possible, even though the lead were kept at a cherry-red heat, at which temperature it is rapidly converted into litharge, we take leave to entirely dissent from. Every known metal has a particular temperature at which, as suddenly as the hardening takes place on cooling in steel, so does the softening or annealing of the metal take place. This temperature, which may be called its annealing temperature, differs for different metals, but is constant for the same metal; and although the precise annealing temperature has never yet been experimentally determined for any one metal, yet it is quite certain that it is one always co-ordinating with the fusing temperature of each metal. The higher the temperature required for fusion, the higher that needed for annealing. This, the annealing temperature of lead, which fuses at 600° Fahr., is so low, that in drawing lead wire or pipe the metal never becomes hard in the draw plate if the drawing be pretty rapid; for so much heat is generated by the violent mechanical change of form as suffices to keep the metal annealed or soft. The annealing temperature of wrought copper is at a low red heat, scarce visible in daylight. That of wrought iron is between a very bright red and a yellow heat, dependent on its qualities; and that of platina is at an intensely white heat, fully as high as the melting point of cast iron. Now the annealing temperature of steel appears to be above that of wrought iron, but below that of platina considerably. Hence we may conclude that to bring a rolled steel plate into its very best and softest and toughest condition by annealing, that operation must commence at a temperature quite equal to what we have stated—viz., a clear bright red by good daylight.

How long it would suffice at a *minimum* that the steel plates should remain *in transitu* in the "*leer*" (to use the glassmakers' term), or annealing furnace, experience alone could decide—probably from four days to a week would amply suffice. Now, except that for that time the hurrying of so much plates out of the gate, and forwarding the invoice would be delayed, we do not see what manufacturing objection can be started to this. The cooled plates should, after their debouchment from the annealing furnace, be sheared to sizes; that mere operation would then afford a tolerable indication of the state of the material of each, and from the pieces shorn off the testing as to coefficient of strength and elongation of *each plate*, upon which we have insisted, should then go on. With a good plant of well-designed apparatus for that, and one or two sets of "provers" and registering clerks, the entire cost of the marking, proof, and registry ought not to add more than a very small sum on the price of the ton of plates—one so small that we feel a strong impression the iron ship or bridge builder would not be permitted by his customers, when these came to know the real advantages, to object to it.

But the difficulties of the steel revolution are not at an end when the steel-master (for we may as naturally call him so as the iron-master at present) shall have placed himself in position to insure delivery of material uniformly and precisely as ordered. Two classes of difficulties of manufacture remain to be dealt with by the ship or bridge builder in his own works. These are dependent—1. Upon the extreme rigidity of steel as compared with wrought iron, which demands several modifications in the methods and tools for working the new material, and necessarily unfits many of the tools already established in ship and bridge builders' yards for working in iron being well employed on steel. 2. Upon the sensitiveness of steel to change its molecular state by sudden change of temperature (as already referred to during the process of manufacturing the raw material), rendering necessary perpetual watchfulness at every step and during every moment that it is in the workman's hands, to be assured that plates or pieces shall not have been unintentionally or unobservedly hardened or partially hardened and made brittle, where they ought to be, and are assumed to have remained, pliable and soft.

In effect, the ship or bridge builder must inevitably for a time, if not constantly, find the working in steel plates and pieces more onerous, risky, and expensive, than working to a similar result in wrought iron. This, more or less, insensibly warps the opinion of many such persons unfavourably towards steel; and the more so, as custom has made a price per ton of finished work a very common measure of payment; and the more material is saved the more the manufacturer suffers, until prices come fairly to readjust themselves to the new material. Once that shall have occurred, a bargain in steel will be found as readily concluded as it is now in iron. The tool difficulty will vanish in the same way, but meanwhile it is, with existing methods, a real one.

One practical limit in plate punching, which experience has proved, is that in the case of wrought iron no punch (power driven) will stand long in work where the thickness of the plate to be punched is greater than the diameter of the punch; but even this much will not hold with steel plates.

Steel is (roughly) probably from twice to three times as hard (rigid as against deformation by partial pressure) as wrought iron. The resistance to a punch going through is proportionate to this, and also to the coefficient of ultimate tension of the material; and that is, roughly, say twice as great (it may be much more) in steel than in iron. Where no *accurate* data for comparison exist, we shall therefore be within safe limits in stating that the resistance to punching steel plates is perhaps, on the whole, four times at least as great as that of wrought iron. This not only affects the rate of progress, the wear and tear of tools, &c., but it results in highly injurious effects upon the material of the punched plate itself. From the small coefficient of final elongation in steel as compared to iron, especially where the steel is very rigid in quality, and, most of all, if unluckily it have got at all hardened during manufacture, it results, that the edge of a punched steel plate is strained almost to bursting by the mere forcing of the punch through it; and there are practical persons who affirm that it is sensibly "hardened" also. Now, subsequent annealing of the punched edges, as has been proposed, while by a possible but risky process it may destroy such hardening, can never restore the distorted steel round the rivet holes to the same tensile resistance as it had before such distortion. If a steel plate punched thus be dissected a little on the surfaces by acid menstrua, and then examined, more especially after a fracture made through the line of holes, with the microscope, it will be found that every hole is surrounded by a number of minute, chiefly radiating, cracks of greater or less length. This is not universally so, but it is so wherever the relations between the sizes of the holes, the thickness of the plate, the quality of the steel, and the rapidity of the punching, have been such as to produce sufficient strain on the metal. No annealing can ever close those cracks, nor ever bring back the particles of the material round and about the holes to the state in which they existed in the plate before it was submitted to the punch. Annealing may (if complete) remove any *elastic strain left after the punching* amongst the particles of the material round about the holes; but inasmuch as those particles have been more or less divulsed from each other, and are no longer in as close contact in all directions as they were before, so is the material round the holes made irremediably weaker than it was before by punching. But this is just the very part of the plate where it is all-important that the full strength of the raw material should be preserved intact. There are several conceivable methods of evading this difficulty in working steel plate. It would be possible to contrive punching machinery which should operate rapidly upon moderately-heated steel plates, and in which the punches themselves should be perpetually preserved quite cold. There need not be time left during the going through and withdrawal of the punch, for the surrounding film of the steel to get hardened by contact with the cold punch to an extent greater than conducted heat from the parts of the plate still more exterior to the hole should restore the softness. It would also be possible perhaps to construct punching machinery in which concentric punches should be employed—the central one thrusting through a small hole in the first instance, so as to relieve greatly the bursting strain producible by the one or more exterior concentric punches immediately following. But most practical men will at once see serious inconveniences, and great trouble and cost, in employing such tools, and an uncertain result in the end. There is, in truth, but one remedy—the resort to drilling. The revolution in material must bring with it a revolution in the plant and tools by which it is to be worked. Punching presses must become obsolete, or be relegated to such employment for iron, as no doubt more or less will for long remain for them; and the piercing tools of the steel ship and bridge builder and steel boiler maker must be, exclusively, well contrived drills of various sorts and sizes. If skilled ingenuity be once steadily directed to the production of such tools, we venture that which may possibly be thought a daring prediction—namely, that tools will be produced which, while operating without injury to the steel, shall, per thousand holes, be found quite as economical as the punching press. But in addition to a total change in the methods of penetration, several other precautions are demanded by the rigidity of steel in the progress of working, so that the material shall not be injured, or its final resistance or its flexibility deteriorated. Bending of plates, bars, or pieces *cold*, which is never, even in wrought iron, unexceptionably good practice, ought to be here absolutely forbidden. The strain, by distortion and disassociation of particles, which may thus be put upon pieces of steel, especially if of thick scantling, and the angle of bending large and sharp, may be enormous. That steel, like every metal or ductile substance, will gradually, more or less, recover from such internal strains—that by mere time, these will approach to a vanishing quantity, and the molecular equilibrium be restored, is true; just because and as steel is so very rigid and so very strong a body, will such changes be almost indefinitely long in taking place, greatly longer at least than is the case with wrought or cast iron. Hence the production of such distorting strains should be avoided just as much as those due to punching. Continual watchfulness, or rather a systematized supervision, with a printed code of explanations and instructions to the workmen, and the sanction of rewards and punishments to the regulations, should exist in every great steel-working shop, to prevent smiths or others charged with the heating or operating hot upon steel in any form from throwing down their work, or in any wise placing pieces while still hot in condition to be suddenly or rapidly cooled, and so more or less hardened.

It is hard to exercise too much caution in this respect. The effects of its neglect may be of the most unlooked-for or disastrous sort. The writer may illustrate this by a fact which occurred in his own experience several years back, and before the great modern advent of steel. For the chain of a 40-ton crane now standing upon the commercial wharf at Kingstown harbour, Ireland, he had employed a flat-linked chain (like that of a watch), and, chiefly to save space, upon the barrel he had the links and pins made of steel in place of iron. The flat links, after each had been forged and bored, were carefully annealed, and the chain was rivetted up, with the precaution that the ends of the three links (middle and two sides) through which any pin was being put were warmed to black redness at that end just before, so that the steel pin, when heated at the one end (that to be closed by rivetting on the links), should not be chilled or hardened. The chain was thus made into four long lengths, and each of these proved with a severe strain. Lastly, these were united into one length by three closing pins, also rivetted. The crane was completed and being proved, when, in lifting a proof load of granite of about 21 tons, the chain snapped in two, and the loose ends flew asunder with a fling that nearly cut through a balk of timber, across which one end struck like a huge sword. On examination, it was proved that the pin which had thus broken off short, was the last one, uniting up the entire chain. The operation had been conducted in the open air, and with all the precautions directed; but at the moment when the rivet was being closed a sudden summer thunder shower had come on. The men dropped the chain, the instant the last blow was given, upon the wet ground, when it was exposed to the heavy rain, and ran for shelter to themselves. The broken pin was found so hard that a "smooth file" would not touch it, and the heated ends of the three adjacent links were also hardened to some extent. All the other parts of the chain were perfect and soft; and when this defective part was remedied, it stood uninjured its full proof load, and continues so in work to the present hour.

Need we draw any moral for the reader further than to ask, What might have been the consequences—what the evil results—to the constructor of this crane had it been for a foreign order, and the chain broken under circumstances where the causes of failure might not have been traceable? Such like bits of carelessness may draw great discredit, and from like conditions, on any steel structure.

The common notion prevalent amongst iron shipbuilders at least, if not amongst civil engineers, as to the future employment of steel in lieu of iron, seems to be to rest content with *low steels*—with steels not having an average coefficient of ultimate tensile resistance of more than 30 or 40 tons; and the notion seems to be that because it is a fact that such steels very commonly possess a greater coefficient of elongation than those of a very much higher ultimate tensile resistance, or, in other words, are, while more than twice as strong as wrought iron, and for the first half or so of their range of tension not very inferior in toughness to wrought iron, so to limit one's self to such, must be the safest practice.

We entertain the strongest doubt that such a view is other than a grave mistake. If we are to secure the utmost advantages that steel can offer to us structurally, it must be by the employment of steel of the very highest resistance, and the very greatest toughness combined, which we can find. We should look for steel that, within double the actual strain to which we purpose to submit it, shall possess the highest value for both the coefficients, T_e and T_r, and thus acquire the means of employing a margin or factor of safety as ample as possible, and far *more* ample than in wrought iron. Where impulsive forces are concerned, this is specially important. It has been shown that a steel gun, with only the same factor of safety and endurance as one of wrought iron, is the more unsafe gun of the two, notwithstanding the superiority of resistance of the material of the lighter steel gun. The same thing is true of an iron bridge or an iron ship, if constructed in steel and with but the factor of safety usual for wrought iron. These structures, with such small and insufficient margins of safety, will, as wholes, be far lighter than if of iron; but let a run off of a heavy engine at speed strike the bridge, or let the ship roll and thump her bottom upon a reef of rock, and the steel so applied, or rather misapplied, shall prove the fatally worse material.

But misconception as to its properties—a want of clearly thinking out and courageously following out into practice the conditions and limitations which nature has set upon the material—alone can cause disasters in the vast future applications and extensions of the use of steel which we hope and believe are before it. Ignorance of these must retard such progress. It has appeared to us that in the few preceding thoughts we might clear up some things which appear to us in that light, and so help forward the career of steel, which has our very best regards.—Ed.

TECHNICAL EDUCATION.

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The writer ventures to contribute to the discussions on technical education some brief suggestions, arising from a somewhat wide experience in technical pursuits, and close intercourse with technical men on the Continent, who are now-a-days commonly assumed to be our superiors, by dint of superior "education."

1st. Before all things, it would seem essential to define precisely the limit of application of the *phrase* which indicates the subject of discussion; because otherwise, one may be arguing on the assumption that "technical *education*" is one thing, whilst another will reply on the assumption that it is quite another thing. However simple this remark may at first sight appear, it is very much a question whether indefinite, or positively inaccurate applications of the term, be not in fact at the root of the wide disparity between published opinions on the subject.

2nd. By considering together the *two* terms *education* and *instruction*, by agreeing that they are by no means convertible, but stand in perfect correlation, nevertheless, one with the other, the writer submits that much confusion may be avoided, and the exact basis of discussion clearly defined. Falling back, then, on the pure etymology of the two terms, education is simply the drawing out, in any given direction, of the mental and physical powers, by way of preparatory training and strengthening, to perform certain work. Thus reading is the first step to exercise the memory; writing, the first to exercise the faculty of imitation; arithmetic, the first to induce reflection and exercise the reason. Beyond these is drawing, a higher exercise of imitation, and having the still higher purpose of bringing the hand and eye to act together. For the attainment of perfect unison of action between eye and hand, the acme of physical *expertness* under mental control, we should add, and do add, in a true gymnasium, the use of the foil in fencing, and the manipulation of the violin in music. Taking a step further, the power to grasp the meaning, force, and phases of language being essential to progress in any conceivable department, we educate or draw out that power by throwing upon our native tongue the sunlight of that language (the Latin, viz.) from which we have taken the great mass of our words which bear on technical matters, and whose grammar sets forth more fully than any other (except Greek) the abstract principles of the correlation of words. Advancing, finally, to the preparation of the faculties of reason and reflection for the higher work of life, we put them through a course of Euclid's Elements and other abstract methods of analysis and synthesis.

3rd. During these processes of education, a certain amount of *knowledge* is imparted to the mind. But the imparting of mere matter-of-fact knowledge is not, or at least ought not to be, the primary purpose. The drawing out of the mental powers (of course conjointly with the physical powers), the bringing them into that healthy tension and activity which fits them to undertake any study and master any knowledge, *that* is, or should be, the main purpose.

4th. I say, of course conjointly with the physical powers, because *mens sana in corpore sano* is a formula by far too much neglected by us, because really and beyond all question the Continental gymnasia are before us and more practically wise in this matter, and because technical education must necessarily in the concrete (however much difference there may be on abstract questions) take into account the power of *manipulation*—whether on the drawing-board, in the laboratory, in the workshop, or in the use of geodetic instruments.

5th. Geography, astronomy, history, and the like, inasmuch as they are an exercise of memory and reasoning, fall within the scope of education to some extent, on the one hand; but inasmuch as, on the other hand, they are so much matter-of-fact knowledge more or less necessary to get through the ordinary business of life, they overlap the province of *instruction*, to which we now come by a natural gradation. They form, indeed, the connecting link or bridge of transition between the purpose of education, distinctly defined on the one hand, and the province of instruction defined with equal distinctness on the other.

6th. Still falling back on pure etymology (and where should we be without our Latin—so much contemned by men who have made their most telling points in the House of Commons through quoting it by the yard), *instruction* must clearly mean that building up, on the previously prepared foundation of *educated* faculties, of the superstructure of *special* knowledge and *special* expertness in *special* departments.

Given—a youth, well trained in reading, writing, arithmetic, geometry, drawing, algebra, elements of physics, and chemistry, to make of him—anything you please, an engineer, an ironfounder, a maker of iron anything, a cotton or a wool spinner, or a mere designer in any of these. If he have aptitude and intelligence, nothing should be more easy; by simply putting him to the special work, and *instructing* him in its processes. He is *educated* for it already.

Given, on the other hand—a youth, not so trained, *not educated*. What can we make of him? Nothing, except by mere chance, which is precisely the position of probably two-thirds of our people, employed in the various grades of our technical pursuits; they are there, and do what is set them to do, by mere chance.

7th. Having thus far defined the mere meaning of words, not so perfectly simple, perhaps, as would seem at first sight, we may be in somewhat better case to consider what should be done in the matter of technical *education*, strictly defined as a *preparatory* process, a foundation to be laid for that technical *instruction* which must come after, and which must, on the face of the matter, be operated by radically different means and method.

The questions of the reorganization and of the extension of existing school systems, and whether these should be subject to the assistance and control of the state, and to what extent, appear to the writer to be such that it is folly to dogmatize upon them. Their solution can only come as a work of time, growing slowly and gradually out of the teaching of circumstances, and the natural inherent development of our exceedingly complicated social conditions. The problem which presses for solution is not so much the *extension* of our schools, as the correction of the radically defective and unscientific *method* of the schools we have. And what is at the root of this defective method, if it be not precisely the confusion between the two distinct operations of education and instruction? Is not a great part of the time spent on generalized treatment of geography, astronomy, even history, and the like, so much waste of energy on the part of the teacher; so much loss of real training to the scholar? Speaking candidly from our own experience, is not all that is learned in early youth of these things straightway forgotten, and is not the real knowledge of them acquired at a later period by voluntary effort and reading? It may safely be affirmed that one "object lesson," which sharpens the powers of observation and reflection, is worth twenty lessons in such subjects as those just indicated. A practical experiment in illustration of some elementary truth of chemistry is worth, to a mere boy, a whole session of indoctrination into the values of symbols.

It is the most beautiful property of the human intelligence that, when it is once wakened into a condition of activity, and brought to a healthy tension by exercise on abstract processes, it cannot, will not, rest there, but goes on then of itself to get hold of the tangible concrete facts. And the constitutional bias of any particular intelligence determines the class of facts upon which it will direct itself; determines, viz., the particular career it should follow. At this point, *education* has done its work, and the work of special instruction must begin.

8th. If the writer be asked—What is, then, to be the staple of education? He would answer—Language, mathematics, physical properties—these three.

Particularly as to language—the vehicle and foundation of all knowledge—the essential is to choose such an one (other than the native tongue, for self-evident reasons) as shall in itself contain, or at least typify, the widest range of philological principles. It seems supererogation to affirm that the choice is between the Latin and the German; these being the two which best conclude in themselves the necessary universality of grammar and construction, by virtue of their position—the one ancient, the other modern—at the head of the Indo-European group.

The idiom of French is so purely special and conversational, that, as an exercise of mental effort, it is utterly valueless in education. It is a mere *acquirement*, like any other dexterity.

The writer agrees that too much time has hitherto been spent in schools on the classic languages; which time, simply, cannot now-a-days be spared. But he also would maintain that a much more thorough, a much more effective grounding in those languages, is attainable with far less expenditure of time, by the adoption of a more rational method of teaching. He conceives that the fundamental error is in putting abstract rules of grammar at the beginning, instead of the end, of the process. But as a practical man, engaged in practical pursuits, he boldly affirms that the Latin has a practical value found in no other language. With a training in the Latin, the acquisition of any other language of the Indo-European group becomes little more than a mere matter of routine.

9th. The value of mathematical training is so universally acknowledged, that the writer desires only to remark that great reform is needed in the method of teaching here also. Every technical department involves as the groundwork of its processes, either graphic delineation on the one hand, or analysis of values on the other, or both inseparably conjoined. And if a rational training in elementary methods and principles of both graphic and analytic mathematics have been neglected, the youth who is put to instruction in any special *technic** is launched on chaos. By a *rational* training, the writer means such as is indicated in the invaluable text-books of Professor de Morgan, of University College, London.

Closely connected with this matter is the art of drawing, both plane and from the round; a matter which by no means holds the place in our primary schools that it ought. The mathematics and drawing are the pith and marrow of technical *education*, are purely educatory, and are the chief bases on which special *instruction* is to be built. They are the hands by which all technical knowledge in detail is to be grasped, and assimilated like food in the mental system.

10th. Elements of physics, including chemistry, follow next in a natural order. In these there is opened to the mind of the scholar the central fact of life, viz., that all nature is governed by law. In unwinding the rationale of law the reflective faculties are still further developed, and their muscle and fibre toned up to the work which comes next.

That work is the application of law to particular technical processes. The work of education has ceased. Instruction now begins its duty. That duty can only be performed (with any approach to practical efficiency) in the workshop, the yard, the laboratory, where the positive things to be *sold* are made, positively in the best way to *insure their being sold*.

11th. Hereabout arises another question of great practical consequence. There seems to be a kind of undefined fancy with many, arising partly from the confusion of ideas and terms already spoken of, partly from inaccurate appreciation of some Continental experiments, that we are to set up schools (dispersed or central) for instruction in particular crafts. We might, indeed, do this to-morrow; but that would leave the matter of *technical education* absolutely untouched. On the other hand, in attempting on a grand scale, a union of the two things, technical education and technical instruction, in the same schools, we should have a hybrid kind of institution, which must infallibly result in eventual failure; because the conception of teaching technic in a school is Utopian, empirical, impractical: Utopian, because never more than a few of the simpler crafts could even be attempted; empirical, because it would be attempting by a *doctrinaire* method, what has been from time immemorial perfectly achieved by the natural method: impractical, because it must necessarily leave out of view the great practical item which is common to all crafts, manufactures, callings, viz., economy. It is of the very essence of technic *instruction* to teach the economizing of time, labour, material, the three elements of all work. But this economy, as every practical man knows, can only be taught under pressure; in plain fact, by driving it into the apprentices by the pressure of rigid "shop" discipline. Economy is the daughter of science, but the fecund mother of commerce. Can this thing whatever be produced cheaper than that other thing? Then this will sweep that incontinently from the markets. Can this man manufacture the particular thing cheaper than that other man? Then this will infallibly beat the other in the neck-and-neck race which, now-a-days, we have all to run. When the writer meets with *one* practical man who believes that it can be taught in schools how to do a thing the *cheapest*, as well as the *best*, way, he will be disposed to think that after all the *doctrinaires* may get their own way in revolutionizing the social organism, and have its laws repealed by Act of Parliament.

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* One may venture to invent a generic term which we do not at present possess, to include headcrafts and handicrafts.

The doctrinaire may of course quote as a complete refutation of these observations, the undoubted success (in their sphere) of what are known as "industrial schools." But the practical man knows that these do not, and cannot, touch the main question. They are special, exceptional, limited in their action and capacity. They no more point to the advantages of a universal technical *instruction* by schools, than the success of hospitals or reformatories points to the advantage of their extension to the whole population. Besides that, the utmost they can do is, by a rough and ready sort of way, to put friendless boys in train to earn a livelihood in the simple crafts, such as carpentry, turnery, painting, and a smattering of smith's-work, bricklaying, and the like.

12th. But the reference to these institutions (of undoubted value in their proper sphere) brings to mind another point, grievously neglected in our schools of all kinds; which is, that concurrent with the training of the mental powers on the one hand, and of the physical powers (by athletic exercises) on the other, the use of what may be termed *elementary tools* should be taught as part of the educational business. The lathe, the saw, the plane, the file, the chisel, the blow-pipe, each has a range of duty running directly or indirectly into every special technic; and each does a valuable work in bringing, as aforesaid, the eye and the hand into unison of action.

13th. Apart, however, from this, there is a certain amount of *preliminary* technical *instruction* which must precede the practical instruction given in the workshop or factory, consisting of the application of the abstract elements to particular cases, by way of preparing the youth finally to learn at the bench or table, or in the yard or field, the actual doing of things. To indicate generally the subjects of this preliminary instruction, one may instance geodesy, applied chemistry, mathematical investigation of strengths and strains, outlines of metallurgy, and the like. These may advantageously be treated in upper classes of even primary schools, or of high schools; or finally, for those ambitious to tread the walks of higher work, in the universities; each of the three supplementing the other. This is a border-land between education and technical *instruction* pure and simple. But even here the limits of technical *education* define themselves with perfect distinctness; because, between the education and the instruction there is fixed that great barrier of *economic work*, beyond which mere education can never penetrate.

The classes for engineering, now fortunately attached to many colleges and schools, are admirable in their scope and object. They afford the definite means of imparting that kind of instruction just spoken of; which is not only of the highest value, but absolutely essential to fit young men for entrance on that special career. But it would be in the last degree unfortunate if the assumption were to pass unchallenged, that a young man who has passed such classes is thereby fitted already to enter at once on the duties of actual business. On this point, again, the doctrinaire and the practical man will no doubt come into collision of argument. But the latter knows that the assumption is absurd, and contrary to the nature of things; and, therefore, hardly cares to waste time in arguing upon it. Actual business is not, and cannot be, done in classes, however perfect. That the doing of a thing cannot be learned without doing it, needs no proof.

14th. If the assumption that any technic can be learned at college be admitted by us, and acted upon, we shall in quick time *come down* to the level of Continental nations in all technical departments. The writer says advisedly, *come down* to their level, because he is prepared to maintain that the impression (amounting almost to panic) which has become general—that the Germans, French, and Belgians are ahead of us already in technical skill and power—is the result of one half exaggeration, and the other half misconception. The whole technical system (especially in the higher branches) of the Continent is vitiated by this very assumption, that colleges can turn out ready-made technists, just as railway bars from the "pile" are turned out from the rolling-mill. Granting to these foreigners the full merit of an extensive and even thorough theoretical information, we shall hardly find one in a score who has acquired, by proper practical training, those invaluable gifts of practical insight, and deftness to originate expedients off-hand in the face of unforeseen difficulties—gifts which, in spite of sparse knowledge, eminently characterize our own people.

There is no doubt something of national constitution and temper in all this. The Englishman is nothing if not practical; the foreigner nothing if not theoretical and speculative. The Scotch, as a people, have the excellent fortune to unite in themselves, in a remarkable degree, both conditions. Hence their universal success: hence the universality of genius in great Scotsmen.

Is it not the fact that the present position of the foreigner in commerce and manufactures is due to his having appropriated, wholesale, the results of British thought, experiment, perseverance, energy, and skill? Let the development of the marvellously scientific details of steam-power, telegraphy, cotton and iron manufacture, and the appliances of agriculture, answer that question. If the foreigner can in any particular produce more cheaply than we, that is dependent on the price of his labour much more than on technical education. If the foreigner can produce our staple manufactures on the same scale (not in isolated cases, which prove nothing) of better, or even equal quality and *fitness for wear and tear*—sample for sample—that remains to be proven. The samples have yet to be put in evidence. By appropriating our processes and expedients, by tempting away our picked foremen, by the assistance of cheaper labour, the foreigner may come abreast of us, but will never pass us in the race, so long as the fertility of expedient, the energy, and the genius of the British brain continue. By bestirring ourselves forthwith in the matter of technical education, and coupling with such schemes as we may devise to that end a closer attention to the laws of social economy, and a religious observance thereof in all things, we need only look on the competition of the foreigner as an additional spur to activity, and an aid to extend our markets.

In conclusion, the writer ventures to offer the following suggestions:—

1. Whether it be not practicable to institute in existing primary schools, high schools, and the universities, and continuous throughout the three, such a curriculum as shall enable all classes to obtain, according to their needs, a technical education of such method and scope as shall give efficient preparation, at its different stages, for the different grades of technical employment.

2. Whether it would not be advisable to enforce such curriculum, by public enactment, on all schools and the universities, whether or not, and altogether apart from the question of, receiving pecuniary aid from the state.

3. Whether some school, as, for example, a high school existing already in the neighbourhood of each university, should, by aid from the state, be erected into a model school for the exhibition of the working of the said curriculum, except so much as pertains to the university itself.

4. Whether the control of the technical curriculum in all schools, and the examination and inspection thereof, should not be lodged in the senates of the universities by public enactment.

COIN AND COINING.

By Joseph Newton, Royal Mint.

(*Continued from page* 40.)

It may be well to state, before leaving the automatic weighing department, that all silver coins, with the exception of threepenny pieces, pass through the same ordeal of individual weighing to which sovereigns and half-sovereigns are submitted. As, however, it is of less importance that two florins, or two shillings, vary in weight than that two sovereigns or two half-sovereigns should differ with each other, a greater allowance is made in reference to silver pieces than in the use of gold. The main point observed in the production of the silver currency is, that a certain number of coins of each denomination shall weigh a certain weight. This arrangement was come to definitively on the 16th June, 1816, when an Act of Parliament was passed to provide for a new silver coinage, and to regulate the currency of the gold and silver moneys of the realm. Its first clause repealed the 18th Charles II. c. 5, which permitted any person, native or foreign, to take plate, silver bullion, or foreign coin, to the Mint, to be there coined into the current money of England.

It then directed that the pound troy of standard silver (eleven ounces, two dwts. fine, and eighteen dwts. alloy) which had hitherto been coined into sixty-two shillings, should thenceforward be coined into sixty-six shillings. Clause 2 enacted, that in future gold coin should be the only legal tender in payment of debts exceeding forty shillings. These provisions remain in force to this hour. The pound troy of silver is coined into sixty-six shillings, or a proportionate number of coins of the other denominations in the silver series. Every piece, nevertheless, above the smallest in value—the threepence—is passed through the automatic balances, so as to minimize individual differences of weight. Threepenny pieces are weighed by the ounce, which yields twenty-two coins.

The pound avoirdupois of bronze is coined respectively into forty-eight pence, eighty half-pence, or one hundred and sixty farthings, and these are not weighed automatically, but simply "pounded," that is, weighed by the pound and counted. Having explained these slight points of divergence as regards the subsidiary coinages, let us return to the gold pieces, which have been tested, and are, to all appearance, ready for circulation. These are once again collected into *journées*, and are sent forward to the central office of receipt and delivery. At that place they undergo an operation, technically known as "pyxing," which is simply the taking at random from each bag a pound weight, and from it retaining two coins, also indiscriminately. One of these pyx pieces is placed in charge of the assayer, who has to determine and report upon the percentage of gold it contains before the bag from which it came can be permitted to pass from the Mint. The second pyx piece is deposited in a sealed packet, there to await the trial of the pyx at Westminster. Other coins are added to the bags to cover deficiencies thus created, and after some further trifling formalities the *journées* are weighed in the presence of Mint and Bank officials, and forwarded to the Bank of England. Silver coin is pyxed in an analogous way. In reference to the *journée* of gold, it may be well to observe, that the law enacts that 20 lbs. weight troy of standard metal shall be coined into 934·50 sovereigns, or 1869·00 half-sovereigns, and this enables us to determine with minute exactness the true theoretical weight of one coin of either denomination. If the 20 lbs. weight troy, for example, has produced the number of sovereigns named, it is only necessary to divide by that number the grains contained in 20 lbs. troy, and the quotient will be the theoretical weight of a single sovereign, viz., 123·27447833 troy grains. The *journée* contains 701 sovereigns, and therefore should weigh 180·03210272 troy ounces. By the same rule a million of sovereigns is found to weigh 256,821·829855377 troy ounces, or about 7·8613 tons avoirdupois. It is usual for the Bank to receive two hundred *journées* of gold coin, or £140,200, three times per week from the Mint during the progress of a gold coinage. During the current year, however, no gold money of any description has been struck at the Mint.

It was promised that some particulars should be given of the ceremony known as the Trial of the Pyx, and in order to do this satisfactorily it will be necessary to trace as briefly as possible its origin and history. Although archæology is not one of the recognized subjects usually treated of in the *Practical Mechanics' Journal*, still when it possesses some direct point of contact with the nature or origin of mechanical or chemical processes, or with their history or that of invention, it very properly comes within the scope of a technical journal. In this way a brief account of that curious remnant of "auld warld wisdom," the Trial of the Pyx, may be admissable here.

When, at a very remote period of English history, mints existed in various cities and towns of the kingdom, it was undoubtedly requisite that checks should exist upon the proceedings of those who managed them. Those checks were wisely introduced and carefully put in force. They consisted mainly in frequent assays and examinations of the coins struck at the respective establishments in question. These trials of the character of the coinage were for many centuries effected within the walls of the provincial mints. Eventually, however, it was thought desirable to institute public examinations of all moneys emanating from those places, and these were known as Trials of the Pyx. According to that praiseworthy and generally exact authority upon minting in primitive days, Ruding, the first of these public trials took place on the 24th February, 1248, and in the 32nd year of the reign of Henry III. The first known writ for authorizing such a trial is dated 1281; and it is tolerably certain that the trial as now put in practice at the Court of Exchequer was really then inaugurated. This was during the reign of Edward I. In 1279 the royal mints of the country had been consolidated under one mint-master, who became party to an agreement with the king for the execution of the coinage of the realm. An ordinance was passed in the same year called Rotulus de Monetâ, or the Roll of the Mint, and intended to regulate the doings of that essential department of the state. A copy of this ordinance is in existence, and it ordains, among various enactments, that "a standard shall be made and kept at the Exchequer, or where the king wished, and that the coin should be made according to the standard of identical goodness." In the sixth clause of the document in question reference is distinctly made to a pyx box, in which was to be deposited a sterling coin out of every ten pounds' weight struck, for the purpose of making the assay or trial. The ordinance also gives explicit instructions as to the custody of the keys of this sacred box, and of which keys there were to be two, one for the master and one for the warden of the Mint.

From this period forward until the reign of Queen Elizabeth the trials seem to have taken place with considerable regularity, and at intervals of three months. During the troublous days of Charles I. trials of the pyx were held at fitful and uncertain times, the probability being that they seemed of less importance than the constantly recurring trials of skill and strength between the unhappy monarch and his parliamentary antagonists. During the Commonwealth it is believed that only one trial of the pyx took place—namely, in 1657. The warrant for this is still extant; it runs as follows:—

> "Oliver P.
>
> "Whereas, amongst other weighty affairs of the Commonwealth, the care of assaying and trying the monies thereof by the standard of England, according to the ancient custom of the realm, is not the least: We, judging it necessary that the trial and assay of the said money be forthwith made, do therefore hereby signify such our will and pleasure to be, commanding you forthwith to cause a trial and assay to be made of the pyx, now being in the Mint, within the Tower of London, by a jury of goldsmiths of our said city of London, of integrity and experience, to be empanuelled on a day certain to be by you in that behalf appointed, in the place accustomed, within our palace of Westminster, and that the lords commissioners of our treasury, the justices of the several benches, and barons of the exchequer, be then there present and counselling and assisting you in the execution of our service.
>
> "Given at Whitehall, the 9th day of November.
>
> "To our trusty and well-beloved Nath. Fiennes and John Lister,
> lords commissioners of our Great Seal of England."

It is clear from the foregoing that in the time of the Protectorate the importance of giving to the public an official guarantee of the purity of the coinage of the realm was quite appreciated. From the date of the Restoration to that of the accession of her Majesty Queen Victoria, such trials took place at very uncertain intervals. During the present reign they have occurred repeatedly, and invariably upon the appointment of a new Master of the Mint, who thus becomes responsible for such coinages as may be struck during his tenure of power. This post, which was formerly vacated when a change of ministry occurred, is now held as a life appointment. Professor Graham, F.R.S., became

Master of the Mint in 1855, and still retains the office. The practice recently has been to cause a trial of the pyx to be made when the Mint pyx boxes become full. There are two such boxes deposited in a strong room in the establishment—one for the reception of gold and the other of silver coins, and each of which is furnished with three locks and keys. The master, the deputy-master, and the queen's assayer hold the keys. The way in which the boxes become charged has been described, whilst the time occupied in charging them of course depends upon the activity or otherwise of the Mint presses.

Allowing that they are full, the fact is then made known to the Treasury, and an order in council speedily arrives for making a trial of the pyx. The chancellor of the exchequer thereupon issues his warrant to the comptroller-general of the exchequer for the production of the standard trial plates and standard weights held in the custody of the exchequer office. The trial plates are strips of the precious metals with corrugated indentations running transversely across their surfaces, and bearing respectively the following inscriptions:—

Goldsmiths' Hall, London.

This standard, commixed of twenty-two carats of fine gold and two carats of alloy in the poundweight troy of Great Britain, was made the 31st day of October, 1829.

Goldsmiths' Hall, London.

This standard, commixed of eleven ounces two pennyweights of fine silver and eighteen pennyweights of alloy in the poundweight troy of Great Britain, was made the 31st day of October, 1829.

These plates have been certified to be of the true standard, not only by the Goldsmiths' Company, but by the authorities of the Mints of Paris and Amsterdam.

Of course there is much form observed in the disentombing of the plates, and their subsequent return to the vault in which they are deposited. Before they are returned, however, small pieces are cut from each for the purpose of effecting the comparative testings which are to be made with the pyx coins. A precept is next issued by the lord chancellor to his loving friends the wardens of the Mystery of Goldsmiths of the city of London, who are thereby required to nominate a jury of sufficient and able freemen of the company, "skilful to judge of and present the faults of the coins, if any be found," and to be present at the place and hour appointed for trial of the same. Many great officers of the state, whose names need not be recapitulated, and among them the Master of the Mint, are also commanded to attend. A very stringent oath is administered to the pyx jury immediately before operations are commenced. The pyx boxes of the Mint, transferred to Goldsmiths' Hall, are now opened, and their contents counted, weighed, and noted. From the whole mass of coins a few pieces of each denomination are taken. These are placed in crucibles, reduced to a molten state, and then cast into ingots of gold and of silver. From the corner of each ingot a small piece of metal is cut, and then the ingots themselves are beaten into thin plates. Blank discs produced from these by punching are weighed with extreme accuracy and placed in envelopes, upon which their individual weights are recorded to the one-thousandth part of a grain. Then follows their assay by the well-known process of "cupellation." Other jurors deal in a similar manner with the cuttings from the trial plates. Finally, reports are made by the two sets of operators, comparisons are instituted, and thus it is ascertained whether the coin from the Mint is better or worse than the true legal standard.

It is satisfactory to be enabled to state that no illegal discrepancy has ever yet been discovered, or, at all events, not since the year 1290, between the pyx pieces and the trial plates.

The theoretical standards of weight and of fineness of both gold and silver coins issued from the Mint have been given, but it is necessary to state that a small latitude or "remedy" is allowed in the trial of the pyx. This remedy, so far as gold is concerned, amounts to one-twentieth of a carat, or twelve grains upon the poundweight troy, both as respects fineness and weight. The remedy upon silver is one pennyweight per pound troy in fineness and in weight.

With such precautions as are now in force at the Royal Mint, it is simply impossible for any coin struck therein and issued to the public to be found out of remedy. The Trial of the Pyx, though supposed to demonstrate this fact and give it the stamp of official truth, is really a work of supererogation, and therefore might well be dispensed with altogether.

(*To be continued.*)

ON SOME POINTS OF PRACTICE IN IRONFOUNDING.

No. XXVIII.

BOXES AND PLANT.

The boxes or moulding flasks, including loam rings, core barrels, and much more of the sort, always contribute a serious mass of half-idle property in every great foundry, and in some with peculiar trades form a rather formidable amount of capital laid up in plant. A great foundry occupied with a single, or with but one or two specialities for its products, which, though the demand must vary, never alter materially in character, such as a great pipe foundry, or one for grate and stove and builders' ware, or for hollow ware, is, in respect of its capital thus buried in tools, very fortunate in comparison with a large jobbing foundry, or still more with the foundry attached to a great engineering establishment, engaged in the production either of engines or of general machinery, or of machine tools. With these last, the mass of property represented by piles of boxes is often immense, and that even when the trade is of one special class, as for example, in marine engine work only, or even in machine tools only.

Locomotive engine making needs probably the least foundry plant; and heavy land engine making, with heavy millwright work and gearing and occasionally other machinery, or mining engines and pumps and other pit work, reach the highest point of almost unavoidable extravagance in this respect.

It is not possible to carry on a great foundry with a variety of work, as in these latter cases, without a vast stock of boxes, and these eat up money, as it were, in more ways than one. A large stock, let us say, has already accumulated, the appurtenances of an old and well-established house, the result of years of trade. Some hundreds of tons of cast and wrought iron is already laid up in boxes, and these, as they are generally likely to be in such a case, where there is room enough, are piled in a more or less orderly fashion over the surface of a great "box yard;" and if the foundry be a well-conducted one, and the proprietors or managers not stupidly penurious, the yard and the boxes are all under the charge of some one responsible foundry labourer, aided by a small gang of men. The business of these men is, or ought to be, to cleanse thoroughly every box after it has been used and is about to be sent to store out of the foundry, before it shall be piled in place again; to remove the box (with the help, if need be, of more or less of the moulding shop labourers) upon a truck back to the box yard, and there to pile it in a proper place, and block it up off the damp ground, if it is to be the lowest of a pile, upon bricks or blocks of wood; and finally to attach with a ring of copper wire to the box, in some conspicuous place, a wood, copper, or zinc label with the dimensions of the box, its weight, and number in the box catalogue painted or stamped upon it.

The box yard ought to be traversed from end to end overhead by a gantry, and the arrangement of the piles ought to be such that by straight narrow lanes or passages between the piles of boxes, inspection of the whole stock should be easy, and that any one box may be hauled out from anywhere, and put upon a truck ready to be taken back to the foundry out of the yard. To be perfect, the yard should have its passages intersected by tramways of about 2½ or 3 feet gauge, and the trucks should run upon these, and by such reach the moulding shop.

The labourer in charge of "the boxes" should keep a stock book. Every box should, on both of or on its several "parts," be numbered in large figures cast on in relief or cut in with a diamond point, and by that number it should be entered in the stock book. That book should be ruled in columns, in which the length, breadth, and free depth for sand, the total weight of each "part," the purpose (if special) of the box, its date when made, and the date when last used, should be entered. Such would be the *beau ideal* of good arrangement for a stock of boxes, and if carried out, the working of the system should be that as soon as the foundry work for the succeeding day—or possibly even earlier—were decided upon, the labourer in charge of the boxes, who should be an old moulding-shop labourer, or a "broken down" (as the sad term is) moulder, possessing intelligence enough generally to know from inspection and measurement of the patterns what boxes will be required for the next day's work, should select from the stock such boxes as he thinks may answer, and report these by their numbers to the general shop foreman of the foundry.

The patterns are now distributed amongst the moulders: let us suppose a large piece of framing to one, some spur or bevel gear of some size to another, some awkward crooked piece of hollow work for engine use to a third. These men, however imperfectly in the end they can be actually held to the responsibility, if even ever so carelessly and ineffectually the work be performed, are nevertheless in their employers' as well as in their own eyes assumed to be responsible for the result of their work, in finished good castings. It is quite conceivable to put a box before one of these men, and insist that he shall employ it, whether he likes it or not; but practically, and as a matter of common sense, in every good foundry, and when the casting is of any size or at all beyond the most vulgar run, the moulder is let to have his own say about the box he is called upon to employ; and no wise foreman will ever stifle or throw cold water upon any well-founded objection to the box, if made by the workman, but will even to a certain extent yield his own opinion, if adverse, on such a point. This, however, needs great discretion, and sometimes a good deal of tact and firmness. The writer has known a first-rate sand moulder object in ingenious but frivolous ways to a box, and suggest all sorts of expensive alterations, or even to make a new one; the real fact being, that he was not pleased with an awkward troublesome job given to him, and would willingly have shirked it. Or sometimes where there is a bad feeling between the foreman of the shop and more or less of the men, such objections are made as mere weapons of annoyance, and to get the foreman into trouble by complaints of tardiness or useless cost of execution. The usual practice, however, is in effect to let each moulder, or each leading moulder of a gang, go and choose his own box out of the yard, and thence comes one of the abuses so hard to avoid. While we have above sketched what might be, or as some would agree, ought to be, the *beau ideal* of the system, as respects the stock of boxes, we doubt if there be probably five foundries in the British Islands in which even an attempt at such order and regularity of system is made, and probably the cases are quite as rare abroad; the only exceptions being in a few vast establishments in Belgium, France, or Germany, such as those of Seraing, Creusot, or Magdeburg. The general habit is to let the used boxes latest thrown out of use accumulate in the moulding shop, stacked up at the sides of the walls, until the encumbrance becomes intolerable and working-floor space impeded. Then a large gang of labourers, and perhaps even some men at moulders' wages, are collected together, perhaps on some Saturday, or at night, or in "after hours," and the "floor is cleared." The boxes are run off upon the trucks anyhow, and shoved off them anyhow and anywhere in the box yard, or purlieus of the foundry, and left for "a more convenient season" to be stacked and matched; and they are never cleaned, nor blocked up, nor kept in repair, nor any catalogue kept, nor does any knowledge exist except in the memory of the "shop foreman" and a few of the "old hands" what boxes exist or do not exist.

There is the picture of slovenly bad management in its worst form; and between the first and the last pictures, the iron founder who reads this may probably recognize the normal management in his own case. But, as we have said, the moulder is sent to select out his own box. He goes through such a yard, shall we say, rather, such a chaos? if he be a far more than usually energetic and conscientious fellow he probably, after a considerable time, does succeed in picking out what he wants. But much more generally the man gets tired and disgusted before long, as he clambers about over disorderly heaps of boxes, laying tape line over one after another, always in danger of breaking his legs amongst "the bars," or of having the ill-stacked piles come down about his ears, and in the end he comes back to report that there is no box in the yard that will answer, and that a new one must be made; or he reports that he can find the "top part," but that the "bottom part" is not to be found, or that one or other part is buried under ten or fifteen tons of other boxes, all of which must be removed to get it out. And, finally, when it has been extracted, "the part" is found broken by the weight unevenly piled over it, and it will take six hours, or a day or more, to repair and make it serviceable.

In any case, there is more or less loss of time and wages by the moulder's promenade in the "box yard;" and where such disorder is the rule, this loss reaches its maximum. The opportunity, too, is a tempting one for the idle workman or apprentice. Smoking is, or if not, ought to be, prohibited while at work (in Great Britain at any rate, as it is very commonly throughout France, though not in Germany); but here, if only two can get away together to the box yard, is a golden chance for a gossip and a smoke, hidden in the maze of box piles, and so a further inducement to lose time and waste wages is superinduced. That all this is no unreal or exaggerated picture, nearly every practical founder who reads this must be conscious. There is no mode of mitigating the evil but *order*, order of that severe arsenal-like character which we have sketched, and which, while itself costing a good deal of money—which to the short-sighted employer seems mere waste—in the end saves itself an hundredfold, here, and in every other department of manufacturing management.

But withal boxes will be found in every great foundry steadily to accumulate; and if the management be good, a periodical *lustration* should be made by carefully going over the box catalogue, marking out all boxes that the changing march of trade, or long use, or accident, or any other causes, may have made useless or comparatively so; and these should be then broken up, removed, and consigned to the cupola.

In a large foundry with which the writer was formerly connected—engaged in a very varied trade in engineering structures, engineering millwork, and general machinery—the space for stacking boxes was rather limited, not being more than about a quarter of an acre outside the foundry. The boxes were numbered, and a catalogue kept, but the piles could not conveniently be commanded by a gantry; and with cramped space, and a travelling crane, or occasionally sheer legs, to lift out boxes, there was not the order desirable, nor was there such a periodical clear sweep, as there ought to have been before each closing of the books, of the halt, the lame, and the blind. At length the writer commanded a general sorting of all the boxes, that all should be weighed, and all old, disabled, or useless boxes broken up. It turned out that the total weight of iron lying dead in boxes was above 1800 tons; and of these about 700 tons proved desirable to be broken up. Some of these boxes were a quarter of a century old; many six or seven years. What had they cost in interest of capital, and in rent of ground occupied, and in waste of wages, during the years they had cumbered the ground and the access to other boxes?

To thus dwell forcibly upon these facts will only seem uncalled for or trivial to one who knows nothing of management, and so undervalues the conditions and circumstances upon which its goodness or badness depends here.

The mechanical construction of large boxes, also, is a matter upon which much judgment ought to be exercised, and in which the methods should always have special regard to the conditions of the foundry and its trade.

The writer recollects many years ago a fine young Lancashire man, who had been reared as a heavy greensand and loam moulder in the foundry of Faucett, Preston, & Co., in the palmy days of the original firm. He got a situation as a working shop foreman in a moderate-sized foundry, forming part of an engine making and general millwright shop in the north of Ireland; and some of his first jobs were to make the castings for a 40-horse factory beam-engine. For the beam, the nozzles, the condenser and air-pump bottom, the bed or floor plate, the columns, the entablature, the fly-wheel segments—for each and every one, he made a new and distinct box, casting the bars into, *i.e.*, in one piece with each.

The proprietor told the writer that the cost of these boxes swept away nearly the whole profit on the engine; and as they probably had not an order for an engine of the same size and build once in three or four years, so these special boxes lay a useless encumbrance, and from the "bars" being cast in, utterly incapable of being made available for anything but that for which they were first made. As to the foreman, who was engaged to work also himself, he was undeniably a magnificent workman, but he had been brought up in one shop and under one routine. "We always had one set of boxes for each job at Faucett's," was with him a sufficient justification; not keeping in mind that "the one job" then at Faucett's meant probably the casting a score of "plantation engines" or of sugar mills, from the same patterns and in the same boxes, hand running. This man no doubt showed great want of *nous* and judgment, but he is only a salient instance of what is more or less continually going on in every foundry.

Where the general foreman really understands the character of the trade he is called upon to manage, he should continually consider, before he sanctions the construction of a new box (supposing the necessity for such at all to have been already established), what is likely to be the degree of demand in which it will pass its after life? If that shall be probably one of frequent or continual duty, then the box ought to be a special one, according to the Faucett practice, though never, in our judgment, with "bars cast in." These should invariably, for large or heavy boxes, be cast separately, and bolted into place. But if the inevitable new and large box is likely to be but seldom employed, then not only let the bars be made loose and bolted into place, but let the sides and ends of the box be cast separately and bolted firmly together. A box so constructed can be lengthened or widened, or even deepened partially, and in fact may be fitted almost to any purpose for which a box of its class can be applied. Moreover, if need be, its parts may be all taken asunder and piled into greatly less space than as a whole it would occupy; and if the main bolts be numbered to their places with centre punch marks, it will take very little time to put together. We shall add, however, in the next article some further remarks upon the principles and practice of box *construction*, this having been wholly occupied with what we may denominate box management.—Ed.

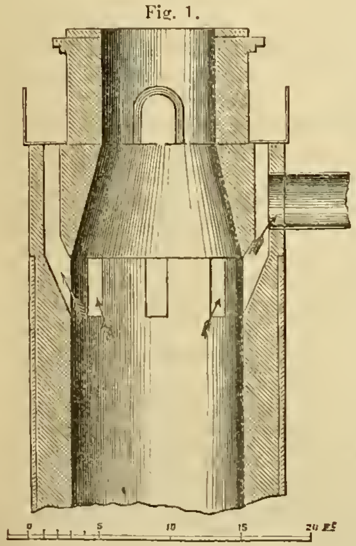
A GLANCE AT THE PRESENT STATE OF SOME BRANCHES OF METALLURGIC PRACTICE IN GREAT BRITAIN.

(*Continued from page* 50).

Scotch Blast Furnaces.

To a large extent in Scotland we have the good fortune of possessing a rich ironstone in contact with the fuel necessary for smelting it, while our furnaces are placed almost at the pit's mouth; and in these respects our Scotch ironmasters stand in a better position than any others. It is, no doubt, owing to first costs being thereby so much lower than in other districts, that our producers have troubled themselves so little about economical working. The waste of fuel in Scotch blast furnaces is most notorious; and even in these dull times, when most of the furnaces are blown out (a most fitting opportunity to make alterations or improvements), it is a deploring truth to utter that we do not find the ironmasters using any means for placing themselves in that position whereby they may, if they will, compete more successfully than of late with the Cleveland masters, and enable themselves to hold that particular, and to a great extent supreme, position which they have so long enjoyed. But the time is not far distant when, if they intend to hold their own, they must submit to and follow the teachings of science in practice. Let us briefly consider what the present state of blast-furnace practice in Scotland is.*

Fig. 1.



We possess a richly carbonaceous ore, which, when calcined, contains from 55 to 70 per cent of metallic iron. It is reduced at a lower temperature than many other ironstones; and, containing 0·5 to 0·75 per cent. of phosphorus, although certainly less than some other ironstones contain, it melts at a low temperature. The fuel used for its reduction in the blast furnace is raw coal. Now, from 2 tons to (in some cases above) 2·5 tons of coal is charged into the furnace per ton of pig iron produced, and this is quite independent of that employed in addition for heating the boilers used in driving the blowing engines and heating the blast, as we must not forget that generally not an inch of gas escaping from the furnaces is utilized, but the whole of it recklessly permitted to cast its heat-power into the surrounding atmosphere; whereas in using coal for smelting, the volume of gases which escapes is immensely greater than with coke, as all the volatile substances pass off in this way, and are therefore available as so much more fuel capable of being usefully applied in the works. But not to be hasty, let us compare this state of matters with that of Cumberland and Cleveland. In the former case, when previously speaking of the practice at Barrow, it was shown that from 19 to 21 cwt. of coke was used per ton of iron produced; and in Cleveland as low as 17 cwt. is sometimes obtained. Now, to make a just comparison with Scotch practice, we must convert the quantity of coal employed into its equivalent coke, because it is only those parts in it which would form coke if it were carburized, but which on account of its caking quality cannot be so converted, that even when used as coal are really available for smelting. Scotch coal contains from about 57 per cent. to 65 per cent. of matter which will form coke; and if we suppose, as we safely may, 60 per cent. for an average, we find that, in coke value, about 30 cwt. is used per ton of pigs produced; that is to say, in other words, that in Scotland, including the fuel for blast ovens and boilers, and working with the richest ore, the fuel consumed per ton of iron is more than double that of the best English practice with the most inferior ores to deal with. Nor may we omit to consider, in addition, that whereas in Scotland only from 2 to 2·25 tons of ore and limestone are charged per ton of iron, at Cleveland 4·25 tons of ore and limestone are used; while in the hæmatite district, where the percentage of iron in the ore is not much below that in the Scotch blackbands, the weight of the two materials is about 2 tons.

The foregoing are not all the facts that may be shown up as indicative of what is going on at our very doors; for we must consider the production per furnace. In Scotland this is seldom over 200 tons per week in the largest furnaces, more frequently less; whilst at Barrow this reaches 500 tons, and even more, per week. What then, under these facts, is it the duty of our ironmasters to do? Most assuredly not to live on *laissez faire* any longer. The remedy is easy. In the first place, let them utilize their "waste gases;" and surely as it is found in the Cleveland district to pay to pull down their old furnaces and build larger, the same thing must be done in Scotland. It is true the soft coal here prevents the carrying of great burthen, hence it is no use to increase the height of the furnaces, but we may enlarge their bulk; for, as we have before shown, although we quadruple the capacity of the furnaces by increasing the diameter, we only double the radiating surface.† We are aware that exception may be taken to the proposal of pulling down existing furnaces, on account of the necessity for immense immediate outlay. Then, although the furnaces remain as they are, that is no reason why the gases from Scotch blast furnaces should not be utilized, for at present certainly less than one-half of the fuel is all that is effectively employed. To show that it will not do to increase the height of Scotch furnaces, it is only necessary to mention that, with their present height of 40 to 50 feet, it is difficult, when the materials approach the tuyeres, to keep the hearth clear of solid matter falling down, thus necessitating the employment of several men to keep the hearth clear from such lumps, which they lift out through the cinder-hole by means of bars. As to increasing the temperature or pressure of the blast, it will be no use to do either, for the furnaces are not high enough to give any advantage by so doing.

We strongly incline to the belief that it would pay in Scotland to import a good coking coal, which, if mixed with Scotch coal, might make a very tolerable flint furnace coke. At all events, as soon as Mr. Aitken's plan of carburizing the ironstone (above referred to, and which, since the date of our last issue, we hear is giving very satisfactory results), comes to be adopted, there is hopes that Scotch blast furnaces may with advantage be made higher.

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* Fig. 1 shows the top of one of the Dundyvan furnaces, and the arrangements for taking off the gases therefrom a few years since practised.

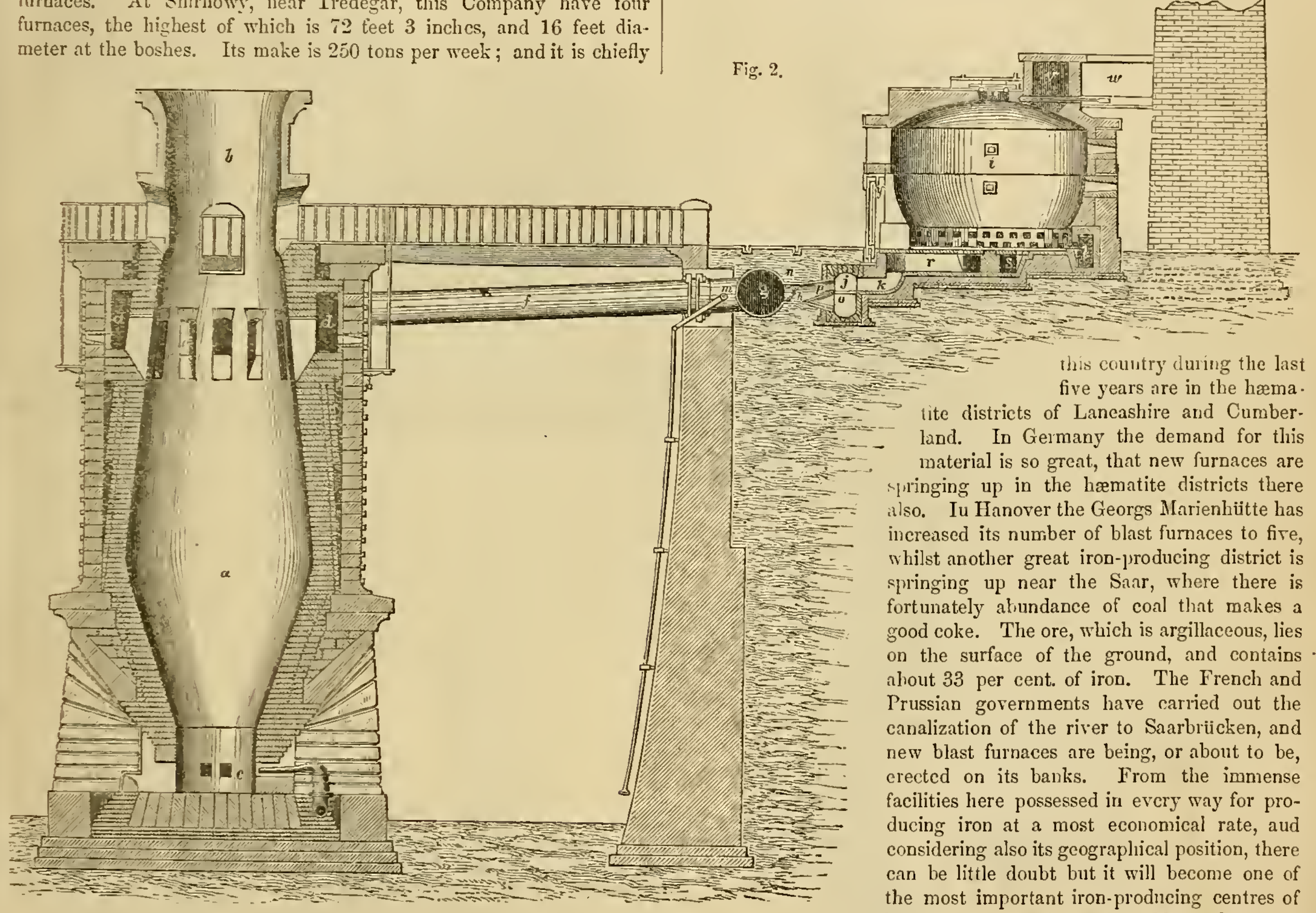
† At the Coltness Ironworks Mr. Houldsworth many years ago utilized, with notable economy, some of the waste gases for calcining a clayband ironstone which is smelted there; and we hear that recently, at Langloan, Messrs. Addie have been conducting some experiments for utilizing the gases, but we are not yet sufficiently acquainted with the details to state what results have been obtained; the accompanying fig. 2, which we reproduce, having been published in this Journal several years ago, shows the Coltness arrangement. Near the top an annular flue or channel, *d*, is formed in the thickness of the sides, and this annular channel has a ring of rectangular or other shaped apertures, *e*, forming the communication between it and the interior of the furnace. On the opposite sides of the furnace two openings are made in the wall, on the outside of the annular flue or channel, *d*, for the insertion of the two elbow branches, *e′*, opening into the two pipes or flues, *f*. The opposite ends of these pipes terminate or open into the main pipe or flue, *g*, which communicates, by branch pipes, *h*, placed upon it at convenient distances, with the calcining or roasting ovens, *i*. Each kiln has two inlet pipes for the gas, as at *a*, *a*, in the first kiln of the series, shown in horizontal section. Each branch, *h*, in place of passing directly into the kiln, opens into a small detached furnace or fireplace, *j*, placed there for the purpose of igniting the gases previous to their entering the kiln by the pipes, *k*, opening from the upper part of the ignition furnace into the annular flue or channel, *l*, formed in the thickness of the wall, near the base of the kiln.

Welsh Blast Furnaces.

In Wales, at the present time, there is not much to consider that is not to be found treated of in substance in some of the preceding remarks. We may, however, allude to some of the Ebbw Vale Co.'s furnaces. At Shirhowy, near Tredegar, this Company have four furnaces, the highest of which is 72 feet 3 inches, and 16 feet diameter at the boshes. Its make is 250 tons per week; and it is chiefly employed in smelting the white and brown spathose ores from the Brendon hills in Somersetshire. It makes a good iron for conversion into steel by the Bessemer converter. The fuel is coked, whilst at other works in Wales it is used raw.

In some of the Welsh ironworks the cost of fuel has recently been much economized by the introduction of coal-washing. The small coal formerly was lost; but this is now separated by washing from pyrites, shale, and other impurities, which from their higher specific gravity sink to the bottom of hopper-shaped tanks which are kept full of water. The bottoms are opened at intervals, and the heavier portions then fall out, the remaining material being afterwards coked, making a fuel very free from sulphur. Coal-washing has long been practised on the Continent; and the sooner we see its universal introduction into Wales and Scotland, and, indeed, into every place where coal is used in the blast furnace, the better.

Fig. 2.



Blast Stoves.

With the high temperature of blast employed in the Cleveland district, some persons prophesied that the heating pipes would be rapidly deteriorated. Now, however, it is the practice to provide a much larger extent of surface per volume of blast forced through them. More than a foot of surface is now allowed per cubic foot of blast supplied per minute; whilst with temperature near 300° Fahrenheit, as formerly employed, from 250 to 500 feet of surface only were provided per 1000 feet of blast per minute. That is now raised in the Cleveland district to between 1200 and 1300.

We find that generally in Europe the trade of the older iron districts is on the decline. We are, indeed, passing but from "an age of iron" to "an age of steel"—this being one of the results that have attended the introduction of the Bessemer process. Wherever we go we meet with blast furnaces being erected for smelting the red hæmatite ores—the only ore yet available for producing iron that can be successfully used in the converter. Nearly all the blast furnaces that have been erected in this country during the last five years are in the hæmatite districts of Lancashire and Cumberland. In Germany the demand for this material is so great, that new furnaces are springing up in the hæmatite districts there also. In Hanover the Georgs Marienhütte has increased its number of blast furnaces to five, whilst another great iron-producing district is springing up near the Saar, where there is fortunately abundance of coal that makes a good coke. The ore, which is argillaceous, lies on the surface of the ground, and contains about 33 per cent. of iron. The French and Prussian governments have carried out the canalization of the river to Saarbrücken, and new blast furnaces are being, or about to be, erected on its banks. From the immense facilities here possessed in every way for producing iron at a most economical rate, and considering also its geographical position, there can be little doubt but it will become one of the most important iron-producing centres of Europe. In Prussia the Cöln-Musen Company have erected five or six new blast furnaces for the production of spiegeleisen pigs; and in Siegen, the very centre of the spiegeleisen manufacture, the production is continually increasing, and in many of the ironworks where charcoal was formerly employed, this has been substituted by coke, adding considerably to the production of the furnaces—the fuel being brought from the neighbourhood of Essen by the railway which has only recently been opened up. In France the iron manufacture is in a less fortunate state than elsewhere on the Continent, for, possessing usually very poor ores at home, they have to import from abroad. England, Elba, Sardinia, and Algiers, are the sources of ore from which the best iron in France is obtained.—V. D.

TARS AND THEIR DERIVATIVES.

In the Part of the *Practical Mechanic's Journal* for September, 1867, appeared the substance of a paper on this subject by M. C. Knab, of Paris, from the "Etudes sur l'Exposition de 1867." We now give some engravings of apparatus used in the treatment of tars, for which we are also indebted to that publication.

Fig. 1 shows an apparatus ordinarily employed for the distillation of tar, drawn to a scale of $\frac{1}{100}$ the full size. A A is a cylindrical iron boiler in which the tar is distilled; F, the fire-grate, surmounted with a chamber, which is extended under the entire boiler its whole length, covering the horizontal flue, C C. From this flue, C, the products of combustion are brought into contact with the sides of the boiler, and circulate round it in the flue, I, before passing into the conduit, J, and thence to the chimney. D, manhole; E, feed-pipe and cock, through which the tar is supplied to the boiler; R, still head, through which the volatilized oils, vapours, and essences are conducted; S S′, worm for effecting the condensation of the vapours; T, conical pipe, forming a communication between the still head and the worm; M, pipe receiving water for the cooling of the worm—the water is introduced at the lower part of the refrigerator, and when heated is discharged by a pipe, S′, situated near the upper part of the refrigerator; N, three pipes for the conveyance of the products which have been condensed in the worm to separate receivers, so that the workman can effect the fractional separation of the products by directing them successively into each of the three collecting pipes; H, cast-iron pipe and cock, used to draw off the residue when the distillation has been completed; R, covered reservoir for the reception of the residue, where it is allowed to stand for several hours, and when cool is run off through the cock, L, either into pits, as in the case of common pitch intended to be used in the manufacture of artificial fuel, or into wooden casks, O, when sheep-smearing pitch is produced. An iron ladder, P, is provided to enable the workman to inspect from time to time the thermometer, X, dipping into the still head, in order to ascertain the temperature of the vapours.

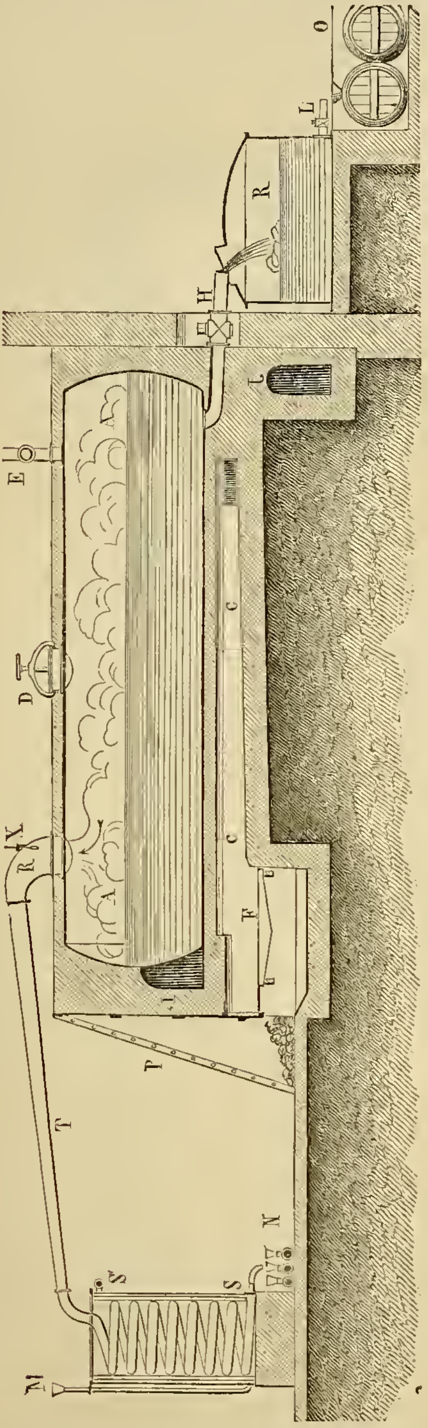


Fig. 1

Fig. 2.

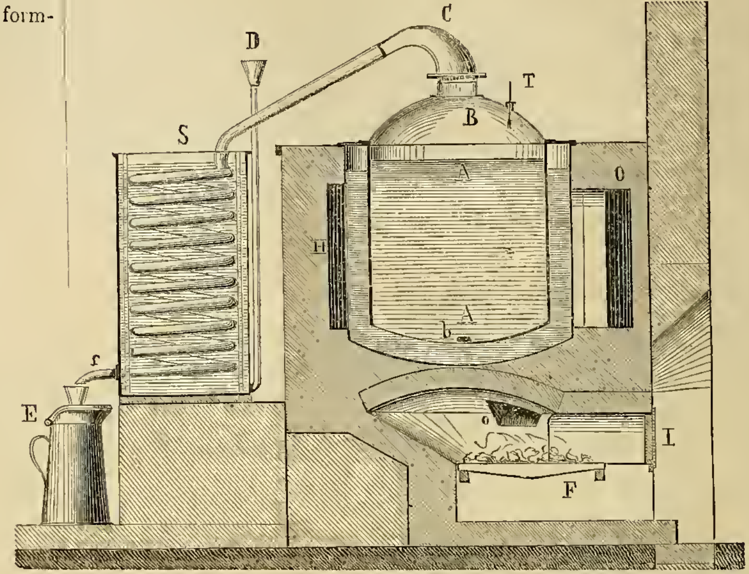
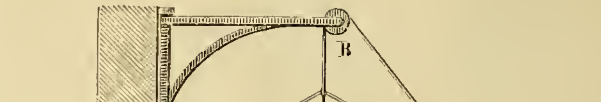


Fig. 2 is a vertical section of an apparatus for the rectification of the essences. A A is the still, into which the essences are introduced through the orifice in the top, after raising the head, C. The boiler is closed by a dome, B, above which is the head, C. A worm, S, serves to condense the vapours, which are cooled by a rapid current of cold water through the pipe, D. The water, when heated, is discharged, as in the apparatus fig. 1, at the upper portion of the vessel containing the

Fig. 3.



worm. The condensed products run out through the tube, *s*, into a closed vessel, E, which is replaced whenever it is required fractionally to separate the distillate. T is the thermometer, the bulb of which, being surrounded by the vapours, indicates when the fractional separations take place.

The distillatory apparatus is placed in a vessel filled with palm oil, as shown in the figure; there is a space of about $4\frac{3}{4}$ inches between the sides of the two vessels. The palm oil, the level of which remains constant, acts as a bath, preserving the internal boiler from the injurious effects of the fire, and regulating the distillation. When the distillation is completed, the residuum is discharged through a pipe passing through the side of the external vessel, the orifice of which is shown at *b*.

Fig. 4.

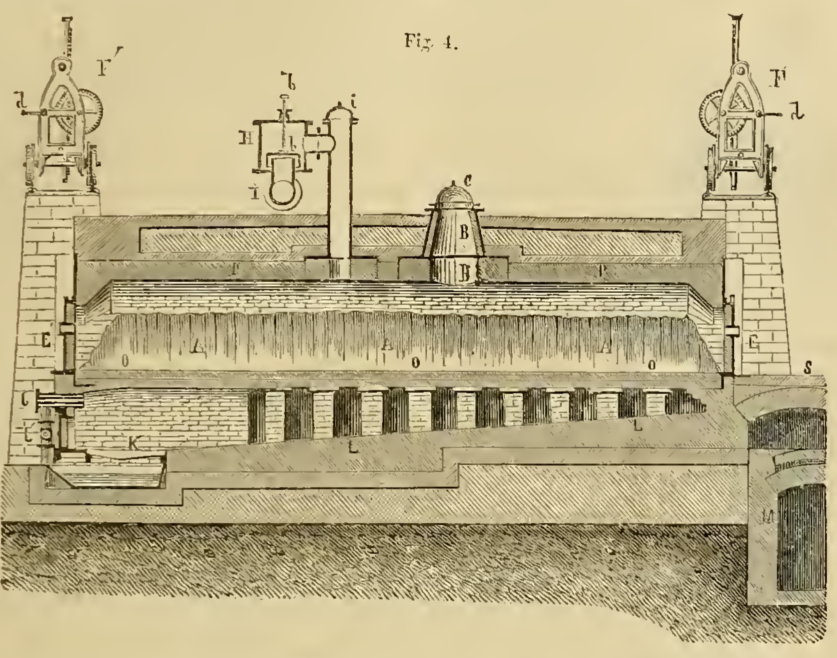
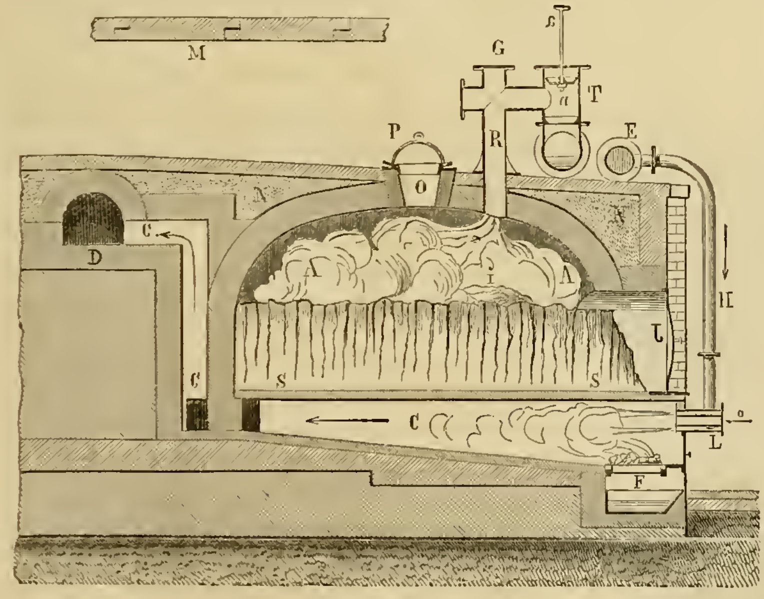


Fig. 5.



The apparatus is heated by an ordinary fireplace, F, vaulted as shown; the products of combustion escape through the aperture, *o*, into a flue, H, circulating around the outer boiler, and then pass into a conduit, O, thence to the chimney.

With a view to diminish the chances of ignition, the furnace door, I, is made to open at the exterior of the rectifying house, the wall having an opening formed in it for that purpose, as shown in the figure.

This rectifying apparatus may be used for all such products the boiling point of which does not exceed 180° Cent. With an apparatus of smaller size, carbolic acid may also be rectified without any danger.

Fig. 3 illustrates an apparatus (scale about $\frac{1}{40}$ full size) by which tolerably large quantities of naphthaline may be obtained as a brilliant white sublimate, specimens of which were to be seen in the late Paris Exhibition. For an operation on a very large scale, it would simply be necessary to increase the proportions of the boiler, and to substitute for the condensing cask a deposit chamber, as is practised in the manufacture of flowers of sulphur.

A A is a boiler (of cast iron) for effecting sublimation, in which is placed the impure but solid and well drained naphthaline, which separates at a low temperature from the heavier tar oils. Before the commencement of each operation the wooden cask is placed over the boiler, T T, which is provided with a hole on its under side of the same size as the diameter of the boiler, and with a small orifice on top for the escape of vapours or non-condensable gases. F is the fireplace, the products of combustion from which escape through the orifice, *s*, made in the flue, are conducted into the channel, C, and from thence to the chimney.

When the fused naphthaline attains to a temperature of 217° Cent. the distillation commences, and heavy vapours are given off, which quickly condense upon the sides of the cask, T. The distillation should be conducted slowly, in order that the interior of the cask may not become heated to the melting point of the naphthaline. After the space of about one hour the cask, the sides of which are covered with crystalline spangles, is carefully removed, and replaced by another.

Tars produced and collected during the manufacture of Coke suitable for Metallurgical purposes.

Messrs. Carvès & Co. exhibited models of improved ovens for the manufacture of coke for metallurgical purposes, by the use of which the ammoniacal salts, so rich in azote, which have hitherto been lost, may be collected and utilized without detriment to the quality of the coke obtained, but on the other hand with an augmentation in its production. Some examples of this new system of oven were also exhibited in the English section; and Belgium now possesses several works where the new apparatus is in use.

When illuminating gas was produced solely in iron retorts, it was considered impossible to construct coke ovens, and even clay retorts, sufficiently impermeable for the gas to be collected without much loss; but Messrs. Pauwels & Debochet demonstrated the practicability of extracting the gas by means of pumps, so as to obviate all pressure in the distilling apparatus. M. Knab was struck with the results obtained by means of Messrs. Pauwels & Dubochet's invention, and conceived the idea of utilizing the gas for the heating of the ovens, after having first condensed and collected the tarry, ammoniacal, and other condensable products. It then became necessary to determine whether the gas, deprived of hydrocarbons of great calorific power, would be sufficient to raise the ovens to the requisite temperature for the production of metallurgical coke. An experiment tried upon a large scale at St. Etienne solved the question of heating by gas alone; but in order to succeed well, it is necessary that a large number of ovens should be worked, so that the production of gas and the heating of the ovens can be carried on with regularity.

The original ovens were constructed in the form and with the arrangement of those erected by Messrs. Pauwels & Dubochet, with the exception of the method of heating, which was so effected that all the condensable products could be collected before the gas was ignited. These ovens were at first rather expensive; but experience has led to a reduction in their cost, and Messrs. Carvès & Co. have succeeded in utilizing the old ovens, by converting them at an expense of £40 each. The so-called Belgian ovens are equally susceptible of conversion; in fact, their narrow and elevated form is even adopted in the new ovens constructed on the improved system.

Messrs. Carvès & Co. exhibited models of these three forms of ovens, the two latter of which are a conclusive answer to the objection of expense of substitution which might be urged against the system.

These three modifications are illustrated by the following figures. We may add that they are now arranged in groups of twenty-five, which insures regularity in the work and in the temperature, each group having a separate chimney.

Fig. 6.

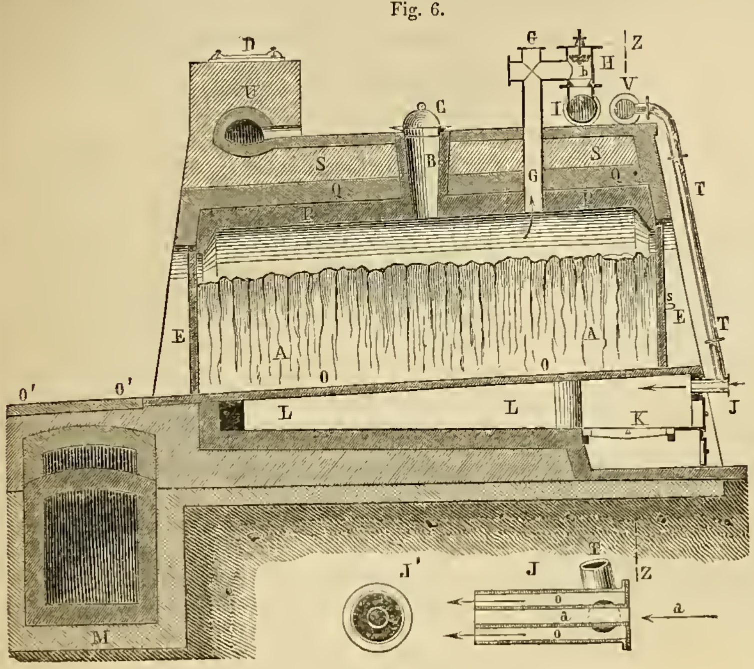
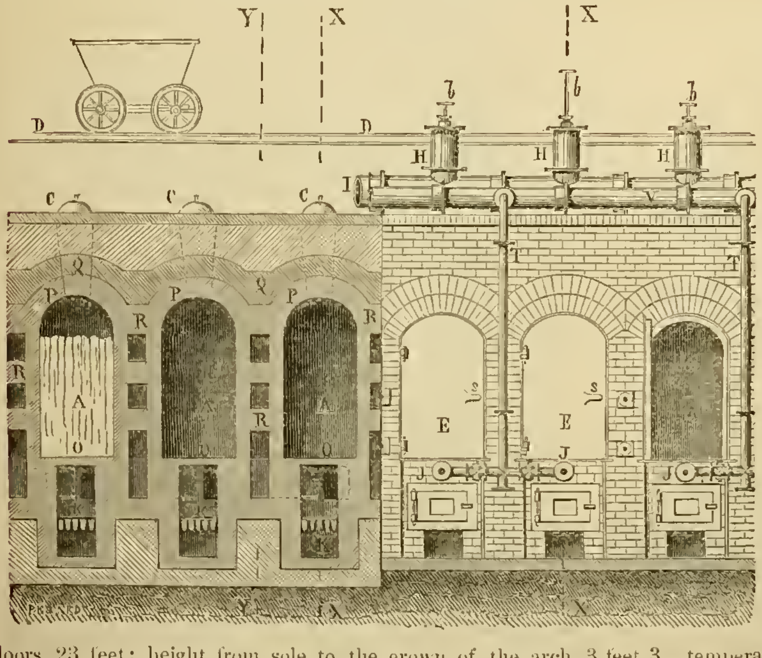


Fig. 4 is a section through the centre of one of the old Dubochet & Pauwel's ovens, converted for the manufacture of metallurgical coke, and heated by gas. This is known as the Knab oven. A A is the oven *proper*, of the following dimensions:—Total length between the two doors, 23 feet; height from sole to the crown of the arch, 3 feet 3 inches; height at the springing point of the roof, 2 feet 3½ inches; width of oven, 4 feet 3 inches. B B, charging orifice, closed by a cover, C, which is luted with clay. The diameter of this orifice is 1 foot 7½ inches at B, and 1 foot 0 inch at B′. A railway is provided for the wagons which convey the coal for the supply of the ovens. E E, cast-iron doors, lined on their interior with refractory bricks, and which close the two ends of the oven; these doors, which are of great weight, are raised by the hoists, F F, which, placed on rails, traverse the whole length of the series of ovens. Apertures are provided for the inspection of the interior of the oven, and for the admission of air when the charge is to be withdrawn. G G, orifice and pipe for the exit of the tarry vapours, gases, and ammoniacal products. H, cylinder which contains the rod and valve, *b b*, that intercept the communication between the ovens and the general conduit, I, when it is desired to empty the oven. It is most essential that the valve should then be closed, as otherwise the operation or exhausting which is effected by the gas extractor being continued, the external air would be admitted, and might probably form explosive mixtures—a circumstance which has, in fact, already taken place at St. Etienne, though not attended with much damage. When conducting the first operation it is also necessary to allow a small quantity of gas to escape before conducting the gas into the gasometer. *i*, cover closing the top of the tube G, and serving to clean out any deposits which may from time to time be formed. I, general conduit conducting the gases and condensable products into the refrigerators, where these latter are deposited, then communicating with the gas extractors, destined to reduce almost to zero the pressure in the interior of the oven. J, pipe injecting the gases into the fireplace under the lower portion of the oven; a concentric tube, *i*, introduces into the centre of the gas ring a current of air from the external atmosphere, and which is drawn in by the draught of the chimney. J′, cock placed over the special conduit which supplies the gases to the pipe, J. K K, a small supplementary fire: the distance between the firebars and the vaulted roof is 2 feet 3½ inches. L L, flues for carrying off the products of combustion; they circulate several times under the sole of the oven, then descend to a lower stage under this first range of flues, and enter the air-conduit, M, leading to the chimney, which is sufficient for twenty-five ovens. Pillars are introduced to support the sole in the principal central flue, L L, which is larger than the others. O, sole of the oven, formed of slabs of refractory clay, arranged so as to break joint, and which are 6 inches in thickness. P, vault of refractory bricks, 8 inches thick. When it is required to empty the oven the cover, C, is opened and the doors, E E′, are raised by means of the hoists, F F′. The *drift* is then inserted through the door, E′, and the mass of coke is pushed out through the door, E, and slides along the platform, S, slightly inclined for that purpose. Care is taken before opening the doors to lower the valve, *b b*.

Fig 7.



This apparatus, after seven years' constant working, was found to answer very well, but was rather cumbersome, and too costly. By substituting the Belgian form of oven a considerable saving is effected, for the same quantity of coal carbonized.

After the information already given respecting the gas ovens, we have but little to add on the working of the special coke ovens.

The impure coal is first washed by the ordinary processes, and then pounded small by means of two grooved cylinders. This pounding is necessary when it is required to obtain coke of a good and regular character; it moreover facilitates the distillation. The pulverized coal is then introduced into the oven, and is evenly spread over its surface until a bed is formed of about 2 feet 3 inches in thickness, sloping down towards the doors. The doors are then closed and luted with clay, and the opening at the top of the oven is also closed, and the valve, *b b*, at the same time opened, which establishes a communication with the cylinder, I, and consequently with the exhauster. The gas cock, J′, is then opened, and the gas, entering the oven, becomes immediately ignited: for notwithstanding the time occupied in emptying the oven, its temperature, and especially that of the flues, still remains very high. The gas when exhausted circulates in pipes kept cool by a current of water, and deposits tar and ammoniacal compounds, and is conducted to the gasometer, which may be common to all the ovens, whence it is conveyed to the fireplace of each oven. At St. Etienne the gas is utilized, both for the purposes of illumination and for heating the distilling apparatus.

The condensed ammoniacal products and tar are received into pits, where, after standing for a week or ten days, they become completely separated, the tar sinking to the bottom. The operation of carburization in each oven lasts seventy-two hours. The products from the combustion of the gases under the sole of the ovens has a temperature of about 800° Cent., one-half of which is sufficient to effect a good draught; a portion of such waste heat is now utilized for other purposes. It has been urged against the plan that the surface of the coal is too large relatively to the mass of coal distilled, and as the heat of the fire is only transmitted gradually through the sole of the oven, it results that the upper portion or layer of the coke being insufficiently heated, is black, and more porous than the rest, which diminishes its commercial value. In order to obviate this defect Messrs. Carvès & Co. cover the bed of coal with a layer of coal dust, which concentrates the heat, and absorbs the remaining traces of the tarry matters.

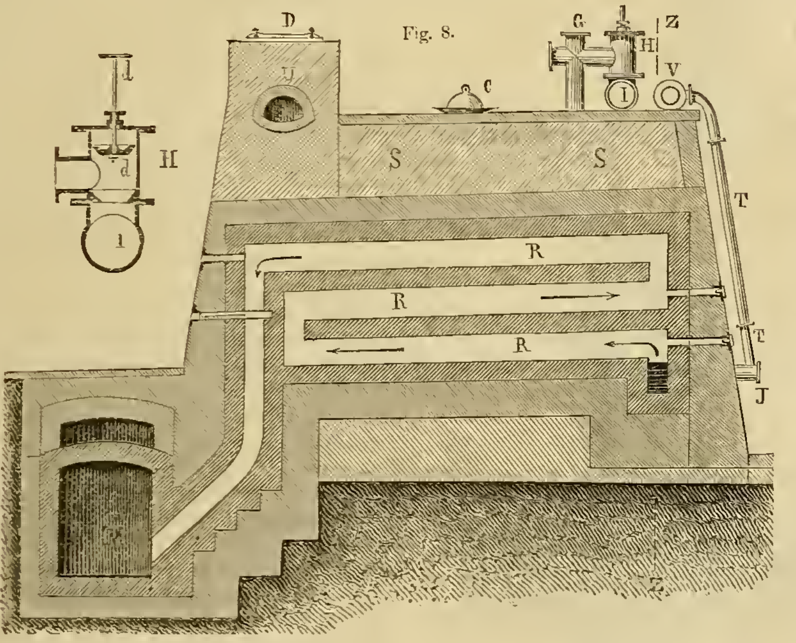


Fig. 8.

Fig. 5 shows a so-called baker's oven, adapted to the new system. A A is the oven proper, which is similar to a baker's oven, being round, and formed with a *surbased* and vaulted roof. It is of the following dimensions:—Diameter of the sole, about 9 feet 9 inches; height under the crown of the vault, 4 feet 10½ inches; height of the charging door, 2 feet 9 inches. O, charging orifice; it is formed of one piece of refractory clay, specially moulded. P, cover to the orifice, the flanges being luted as in gas retorts. There is a railway above for the wagons, laden with coal to be carburized. J, sheet-iron door, to close the opening provided for the emptying of the oven, which is effected by hand, in order to prevent loss of heat. R, pipe for the outlet of the gases, withdrawn by the exhauster, on Gargan's system, which is constructed on the same principle as the exhauster and blast engines. G, pipe connected with the pipe, R, and which contains the valve, *a*, destined to intercept the communication at the time of emptying the oven. E, pipe common to the entire group of ovens. H, gas main common to the group, supplying the gases from the gasometer. L, pipe branching out of the general conduit, and feeding each oven. F, small supplementary fireplace. S S, sole of oven, constructed of slabs of refractory clay, arranged to break joint, as shown in detail at M. The products of combustion are first conducted into a central flue, and then circulate under the sole of the oven, and sometimes pass along its sides, whence, passing through another flue into a general canal, they are conducted to the chimney. The gas exhauster is driven by a 10 horse-power engine; one exhauster is sufficient for about 100 ovens.

The Belgian oven, as now adapted to the new system, is shown in the three following engravings:—Fig. 6 is a vertical section taken on the line, X X (fig. 7); fig. 7 is a vertical section taken on the line, Z Z (figs. 6 and 8); and fig. 8, a section through Y Y (figs. 7), drawn to a scale of $\frac{1}{80}$th the full size. A A, is the oven proper, represented as charged with coke; it is narrow and lofty, surmounted by a semicircular refractory roof, and heated not only under the sole, but also on the two sides by means of flues, carried up to the height of the upper layer of the bed of coal. The following are the principal dimensions of the oven—viz., total length of sole between the two end doors, 15 feet 9 inches; width of the oven, 2 feet 7½ inches; height, 5 feet 9 inches; total thickness at top of vault, 2 feet 10½ inches. Its capacity is equal to that of ovens No. 1 and No. 2—viz., 5 tons of coal. B, conical opening for charging the oven, with a cover, C. D, railway for supplying the ovens. E E, doors for the removal of the coke from the oven, which is effected as in fig. 1; the doors turn on hinges, and are lined with refractory bricks and luted with clay. G G, pipe for the outlet of the gases exhausted by a "Bell extractor," constructed on the principle of winged ventilators, and working at a high speed. H, tube containing the valve, *d* (shown in detail in fig. 8), and connected with the pipe, G. I, general conduit, receiving the gas and vapours from the entire group of ovens. J, gas pipe for heating the ovens, shown in detail at J and J′, fig 6; the gas arriving from the main, V, common to twenty-five ovens, through the pipe, T, feeds two fires. *a*, central pipe, open at both ends for the passage of the air exhausted by the draught of the fire; the gases, the supply of which may be regulated at will by means of a cock (fig. 7), arrive through the surrounding pipe, *o*, closed at one end, and open at the end next the fire; the air thus enters in the centre of the ring of burning gas. K, supplementary fireplace, which serves only to commence the heating of the ovens, and to burn the cinders and small coke, more particularly when a portion of the gas is employed to heat other apparatus in addition to the ovens. L L, flues for the circulation of the products of combustion under the sole of the ovens; they first enter a flue on the right hand under the sole, and then pass into a left hand flue, whence they are carried up successively into three superposed flues, R, which heat the sides of the oven, and then escape through a general conduit, M, to the chimney. Each furnace heats the sole and one side of the oven, the flues, R, being common to the walls of two ovens. O O, the sole, slightly inclined as shown, to facilitate the removal of the coke. P P, vaulted roof of the oven, composed of refractory bricks, covered by another vault, Q Q, and then by stonework set in grout, S S. The roof is inclined in order to collect the rain water and conduct it into a gutter, U.

Owing to the method of heating, and the distribution of the flues, the temperature is higher in the Belgian ovens, and the operation lasts only ninety hours—that is, one-sixth less than with the other two forms.

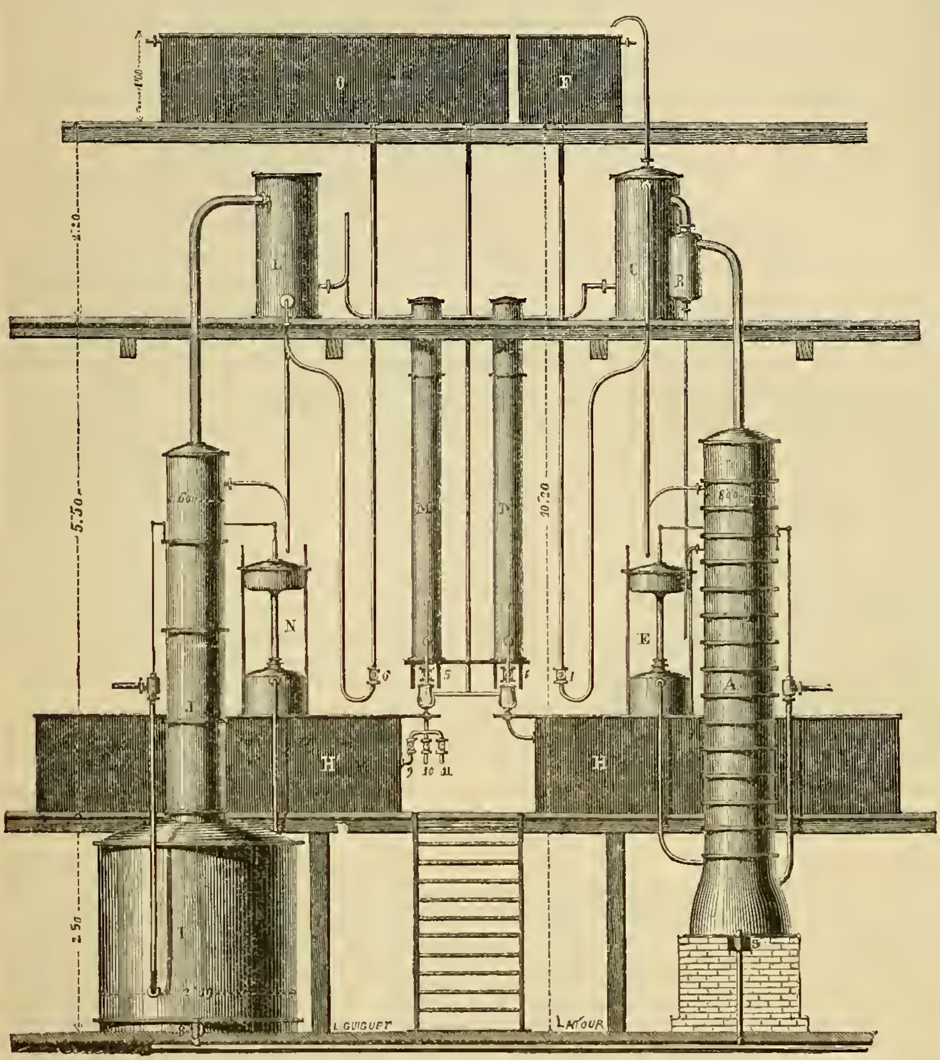
The tars from coke ovens are not altogether of the same composition as those obtained from gas retorts; they contain but a small quantity of benzole and toluol. They yield, by a preliminary distillation, about 5 per cent. of their weight of light oils, &c., marking about 16° or 17° Cartier, from which about 50 per cent. of hydrocarbons, distilling at about 150°, can be extracted by rectification, and sold as benzole, naphtha, &c.

Phenic acid is found in very small quantities in these tars—viz., about one-half per cent only of their weight in its pure and crystallized state; but, on the other hand, there is extracted a larger proportion of its homologue, with which Messrs. Carvès & Co. manufacture and supply a very beautiful yellow dye, discovered by them, and called safranine, which in richness of colour surpasses picric acid, and which is also cheaper, and the tints of which extend from yellow to red They also manufacture from oven tars another colour of their invention—viz., muréine, which yields chiefly various gray tints—very pure and fast colours. Specimens of both these colours were exhibited in the late Paris Exhibition. The treatment of the ammoniacal water collected is similar to that adopted in gas works. The principal ammoniacal salt manufactured at St. Etienne is the sulphate, which is used in the manufacture of alum and of artificial manures.

THE SAVALLE DISTILLATORY APPARATUS.

At the Paris Exhibition of 1867 a gold medal was awarded to Messrs. D. Savalle, jun., & Co. for their apparatus employed in the distillation and purifying of alcohols obtained from wine, beet-root, molasses, grain, or other sources.

The reputation of French wines, and the incomparable alcoholic products of Cognac and Armagnac, stand unrivalled. For the last fifteen years the distillation of beet-root, molasses, grain, lees, &c., has produced immense quantities of alcohol; and thanks to accomplished improvements, it has become an industry of most important consideration from its close alliance with agriculture. Agricultural distillation, which gains ground daily, has entered into a powerful competition with vinous alcohols. In 1866 France produced 44,000,000 gallons of alcohol of all sorts, of a value of £8,000,000; agricultural distilleries produced $\frac{4}{10}$ths of this amount.



The Savalle apparatus is the most important advance that has recently been made. It is to its employment that the first distilleries of Germany owe their superiority.

Both for distillation and rectification the principle of this apparatus is the same; it rests on the difference of calorific capacity of the alcohol and of the bodies which are associated with it, and on the continuous separation and elimination of the different products of distillation. This principle is of easy application, the apparatus being constructed so as to utilize all the heat by infinitely dividing the liquid to be dealcoholized, and bringing it into immediate contact with the heat particle by particle, so that no atom can escape the reaction. By the effect of this ingenious combination each metre of surface produces a useful effect five times as great as with the ordinary apparatus; and the alcohol vapours, purified by repeated washings, escape at one side, whilst the inert and infecting matters are collected at the other side.

The distillation is accomplished in a continuous manner for wine distilled without water. But the rectification of the raw alcohols is an intermittent operation. The stills are composed of a boiler, a distilling column, an analyzing condenser, a refrigerator, a special recipient for essential oils, and a regulator for the admission of the steam. For simple distillation a special boiler is not necessary, the steam generator for the pumping engine, which supplies steam to the column, serving the purpose; but the case is different when rectification is required. The column consists of a metallic cylinder, containing in the interior a number of superposed diaphragms of sufficient number and dimensions to produce the extreme division of the alcoholic liquid and the heat, and to force the vapours of alcohol to be cleansed from all foreign bodies. On quitting the column the vapours enter into the separating condenser; they contain water, alcohol, organic acids, ethers, essential oils, and different hydrocarburets, and are submitted to a temperature which obliges each of these bodies to obey the laws of its specific heat, and to undergo a first analysis, rejecting the denser bodies upon the diaphragms of the column, and allowing those more volatile to escape. The condenser communicates with the refrigerator, and conveys into it the fluids which have preserved the form of vapour. These latter, introduced into the refrigerator with a calculated pressure, expand and meet with a number of points of contact, which condense them rapidly into a liquid state, in which they pass into the tester, or *éprouvette*, a crystal prover, where they are examined as to strength, temperature, and quantity, per hour.

Both the condenser and refrigerator are tubular, so as to cool rapidly. The heating surfaces and those for washing in the column have been calculated most accurately with regard to the surfaces of condensation and refrigeration of the condenser and refrigerator. Thus, with the maximum useful effect corresponding to the minimum of expense, fuel, force, time, and water, the Savalle still produces, per hour, five times as much alcohol as ordinary stills of the same size, and more regularly and economically. Also by the same apparatus the rectification, well conducted, of agricultural alcohols renders them of a purity superior to spirits of wine.

The accompanying engraving shows an apparatus, constructed by Messrs. D. Savalle, jun., & Co., wherein the distilling and rectifying stills are united. It is particularly adapted for rapidly and economically distilling alcohol at 68° to 70° above proof from beet-root, grain, molasses, &c. A is the distilling column; B, the froth clearer, for preventing the wine from passing into the *éprouvette;* C, the condenser; D, the refrigerator; E, the regulator, containing a self-acting float which equalizes the supply of steam to (and consequently the temperature of) the still, A. This is a most ingenious invention by M. Savalle, and is so contrived that when the steam pressure is too great it forces water contained in the lower portion up the small pipe, E, into the upper compartment containing a float. This latter by rising or falling opens or closes a regulating valve for admitting steam to the column; F is the water reservoir; H H′, alcohol reservoirs; I, boiler of the rectifying still; J, rectifying column; L, the condenser of the still, J I; M is the refrigerator; N, the regulator; and O, the water reservoir.

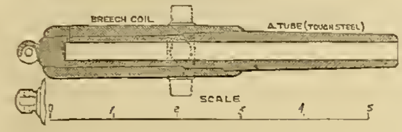
These distilling and rectifying stills utilize all their effect to the best advantage. The quantity of finest spirit obtained is 90 per 100 of the quantities submitted; sometimes it attains 98—viz., *the highest limit of the dehydration of alcohol without the aid of chemical agents.*

In 1866 and 1867 Messrs. Savalle & Co. erected no less than 261 stills, capable of producing 217,400 gallons per day. We learn that thirty-eight of these stills alone were sold during the Paris Exhibition of 1867. An apparatus, similar to that of which we give an illustration, is in course of preparation for the International Maritime Exhibition to be held at Havre in June.

THE FRAZER GUNS, WOOLWICH.

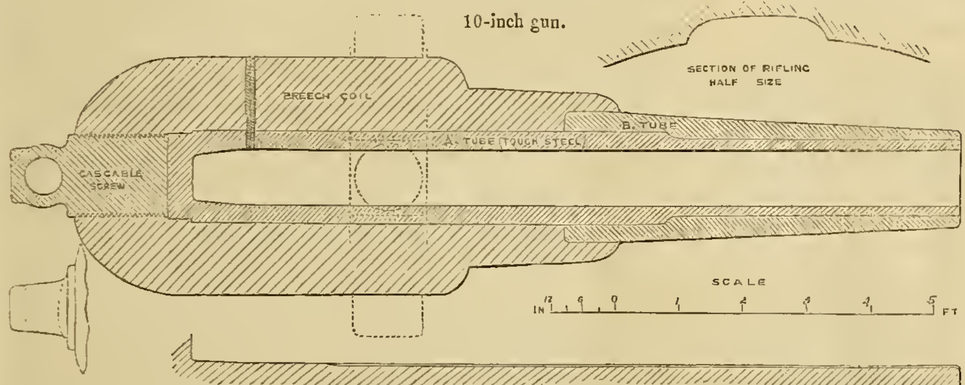
THE illustrations adjoining present to our readers three typical natures of guns, viz.,—the field gun, the heavy gun for position, garrison, or naval use, and the 20-inch monster of 61 tons' weight, designed to cope with the American Rodman guns of same calibre—which constitute the very latest and one of the most important of the successive improvements through which the manufacture of wrought-iron ordnance has reached its present stage at Woolwich, and in our British service.

12-lb gun.



The Armstrong gun, as it is popularly called—and the term used as though Mr. Armstrong (now Sir William) had been the inventor of built-up guns, *i.e.*, guns formed in rings superimposed with initial tension—was a vast advance upon the most advanced prior effort in wrought iron, which, we may say, was perhaps the Mersey Co.'s 23-ton 13-inch gun forged in one mass.

10-inch gun.



The theory of such ringed structures, once it had been rendered mathematically clear by Dr. Hart, of Trinity College, Dublin, clearly pointed to the fact that the strength as against bursting of a built-up gun, as compared with one of the same dimensions and material in one solid mass, tended continually to approach the limit of the ratio, as—

$$\frac{D'-D''}{D''} : \frac{D'^2-D''^2}{D'^2+D''^2};$$

but that limit can never be reached unless the number of the superposed rings be infinite, and so the thickness of each evanescent.

The earliest ordnance constructed of any size in England, or in the world, upon this known principle, were Mr. Mallet's 36-inch mortars, which were built up in eight or nine superposed thicknesses of only about two inches each. The constant tendency of all artillerists, until a late period, was to co-ordinate as nearly as practicable to theory; and so the rings of the Armstrong guns have been multiplied and made thin. This involved many practical difficulties of manufacture, and great expense.

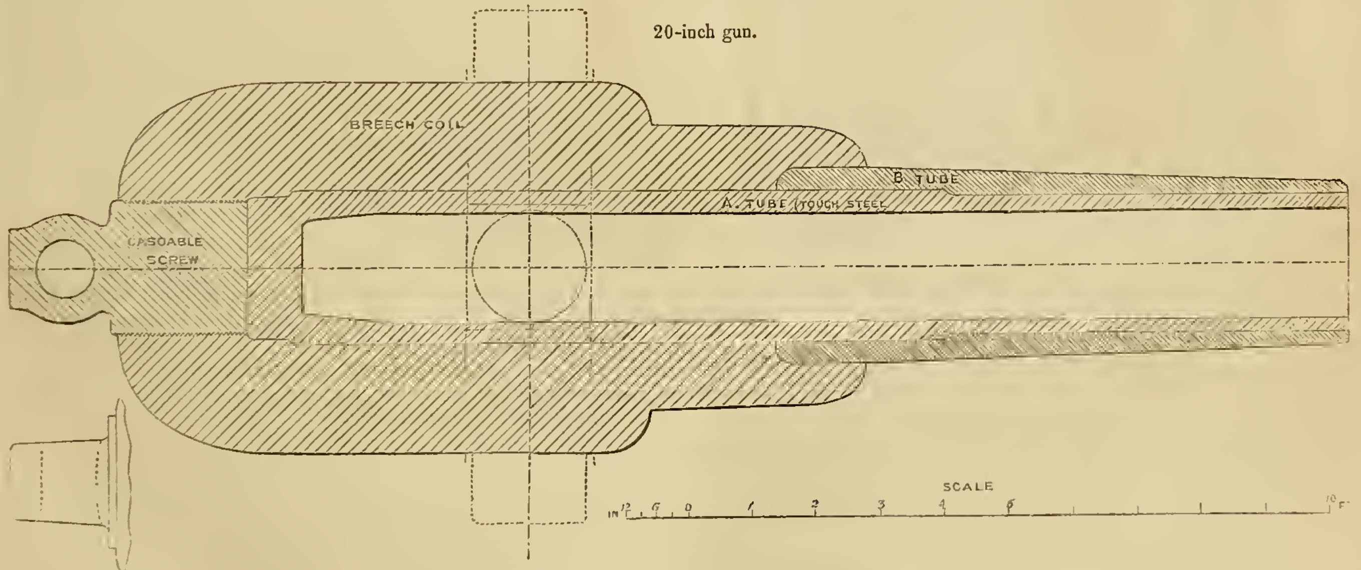
It has been due to Mr. Frazer, the present sub-superintendent of the Royal Gun Factories, Woolwich, well supported by Colonel Clerk, R.A., his immediate superior, to discern, inaugurate, and carry to perfection a vast improvement, by rightly steering in that *via media* between the dictates of pure mechanical theory, and the practical suggestions of prudence and good sense derived from great experience in the workshop, and to construct built-up guns in far thicker coils or rings than previously was deemed wise, if even admitted to be possible.

The Frazer guns are constructed practically with all the advantages of the thin-ringed Armstrongs, and freed from all their disadvantages. The inner tubes are of low steel, forged in a solid cylinder, and bored out. Upon these are shrunk either a single outer ring, as in the field guns, which, in fact, consist but of two parts, or two rings, as in the heavy battering guns.

All natures of ordnance are thus brought to two common types, and all of a given nature are exact counterparts of each other, and their simple parts may be used interchangeably.

The great revolution has been in the thickening of the outer coils, which are of wrought iron—not, as formerly, of hard-to-weld Yorkshire iron, but of easily welded and very tractable Staffordshire iron, at a much lower price per ton.

20-inch gun.



Each thick coil consists of two spirals, whose twists are in opposite directions—one placed within the other—the spirals being formed, as always, by rolling up upon a mandrel prismatic rolled bars.

These double-spiralled thick coils are heated vertically in air furnaces in one mass, sometimes already weighing upwards of twenty-five tons. They are lifted out vertically when at the welding heat by gigantic tongs (which alone weigh nine tons for the largest), and by half a dozen blows, all given end-on by the steam-hammer, the whole mass is welded into a united piece. A magnificent plant has been indispensable to enable this to have been carried out, and the result is, that the economy of manufacture of the Frazer guns reaches *forty per cent.*, it is stated, and we believe truly, upon the former cost of the Armstrongs. Many highly important subsidiary advantages are obtained by this method of manufacture, which we cannot devote space at present to descant upon. Amongst these, however, we must not omit now to mention this, that the rate of supply of guns of the heaviest class from the gun factories has been greatly accelerated; and that there need be no grounds hereafter for periodical complaints and panic in the papers and in Parliament, that, with all the expenditure and all the apparatus of Woolwich, it is yet found impossible to get heavy guns fast enough for the demands even of the navy alone, and even in times like these of peace. This may have been so, but it is no longer true. Colonel Clerk, R.A., we believe, is ready to deliver twenty guns per week, with ease, of the heaviest natures, and of smaller natures, say 40-pounders and below it, *ad libitum.*—Ed.

AMERICAN PLANING MACHINERY.

SELLERS & CO.'S PLANING MACHINES.

(*Illustrated by Plate* 3.)

Amidst the countless machine tools exhibited last year at Paris by every foremost maker in every prominent nation in the world, there were none so remarkable for the breezy freshness and originality in the conception and carrying out of the contrivance of various parts, by which the combined action of each machine tool as a whole was obtained, as those produced in the United States division by Messrs. William Sellers & Company, of Philadelphia.

The choice of contrivance in special parts was often as novel as it was ingenious and effective. In one or two points the choice (as is the case with all choices) was open to criticism, and we were ourselves present at some discussions at the Exhibition, at which, as our neighbours say, competent men " assisted," when some of these contrivances were discussed, but although the designer and constructor of these very elegant machines had not the advantage of being personally present to answer objections, we do but justice to him to say, that after each such little debate, our own opinion of the merits of these American machines was strengthened.

They did not, as it appears to us, attract the amount of attention they ought to have done last year either in France or in England. That will probably increase, however, as time admits of their being more fully considered than during the " hurley burley " of the Exhibition; just as it is said that first-class works of fine art do not proclaim their merits to him that runs, but that these show themselves one by one to the more patient regarder. On the other hand, however, throughout Europe we perceived but one note of slight or depreciation of these United States machines, and that was from an English paper edited by an American. Whether this was intended as a bidding, to show how *ultra* impartial and above national prejudice an Anglicised Yankee can become when in the editor's chair, or not, it indicates something of the amount of reliance that may be placed upon the judgment of the print in question.

At our special request, we have been favoured by Messrs. Sellers with complete sets of working drawings of their most important machine tools, and from these we select for our copper-plate of this month their great planing machine, with moveable head and tool-holders and fixed beds, exhibited at Paris. We subjoin a brief description of this machine, enough to render its arrangements intelligible to our readers. In a subsequent part we shall engrave another of their planing machines, different wholly from this, and before passing then to any other of Messrs. Sellers' tools, of which probably we shall engrave hereafter some, we shall describe the latter planing machine, accompanied by a few critical remarks.

For planing machines of large dimensions and heavy work, the usual plan of fastening the work to a table sliding back and forward on ways or beds is found disadvantageous in several important respects; the length occupied in the workshop by such a machine—being twice that of the longest piece it is capable of planing—becomes an important objection, but a more serious defect arises with the necessity of reversing and moving at each end of the stroke any work of the heavier class.

With a view to overcome the above disadvantages, some machines have been built with the crosshead attached to slides moving and guided in ways fastened to walls of masonry, motion being communicated to the slides and crosshead by means of screws or chains attached to and supported by the ways; the materials to be planed resting on platforms or cross beams in the pit formed by the side walls. The crosshead of such machines having no vertical adjustment, the platforms which support the work had to be raised or depressed to suit the varying heights of the material. In order to decrease the depth of the pit, short uprights, with a vertical adjustment of the crosshead upon them, have sometimes been used, but all machines of this class have heretofore used platforms to support the material to be operated upon, which are either adjustable in height to suit the varying heights of the material, or require that this, when small, should be elevated above the platform to come within reach of the planing tool. This form of machine overcomes the disadvantages of the ordinary planer for heavy work, both as regards the taking up of room and weight of moving parts, which will generally be much lighter than the sliding table and work to be operated upon, and thus require less driving power. But it must be admitted that the necessity of either lowering the work into a pit, or raising the material from the platform so as to come within reach of the cutting tool, is another objection; on account of the inconvenience and liability to inaccuracy arising with the use of a series of adjustable and disconnected supports for the work within a pit, such supports being separate from the sliding ways, so that perfect parallelism of surfaces and absolute accuracy of work becomes almost a mechanical impossibility. In the machine we are about to describe these defects are avoided, and it combines, with all the advantages of a traversing tool frame, those of the old form of planer for convenient handling and solid and accurate adjustment of the material to be planed.

The main feature of this novel construction consists in supporting the work to be operated upon on a stationary platform, A, and the crosshead, B, upon uprights or posts, C, as in machines of ordinary construction; but these uprights are so arranged as to slide in ways, D D, provided for the purpose in the sides of the stationary platform, so that the slides which govern the position of the tool are below the work to be operated upon in place of above it as heretofore, and the crosshead, B, can be elevated and depressed upon the uprights to suit the varying heights of the work, in place of elevating and depressing the platform.

The method adopted for moving the uprights and crosshead, so as to perform the work required is as follows:—The stationary platform, A, of the machine has on either side of it racks, E E, and planed ways, D, of the shape shown in the engraving; the uprights are provided with slides F F, made to fit the V-sides accurately, by means of adjustable taper shoes on their upper side. At the top the uprights are secured together by means of a hollow casting, G, forming a rigid cross girt. In each of the uprights are stout vertical shafts, H, at the lower end of which are driving pinions I, gearing with the racks, E, in the bed, while on the upper end of the shafts are worm wheels, J, inclosed in cases in the uprights, retaining the oil used in lubricating. The two worm wheels, J, are driven by worms, K, one being right and the other a left hand thread. The two worms are united by a hollow shaft or sleeve, L, and each of them provided with a spherically shaped step-plate, to insure a perfect fit on the rubbing surfaces next to the worms. The left hand worm shaft extends through its case, and has at its outer end a spur wheel, M, fitted upon a friction clutch, N, with which it is held in driving contact by means of a screw and washer on the end of the shaft. Into opposite sides of this wheel gear two pinions, O and P, of equal size; the shafts of these pinions are each provided with a narrow fast pulley and wide loose pulley, but so placed as to have each fast pulley opposite to the loose pulley of the other set. The pulleys, Q, R, next to the back of the upright are twice as large as the front set, S, T, and the top of the last named set is somewhat above the top of the large set, so that the belt passing clear of the large pulley and around the small pulley, then back around the large pulley in the manner shown in the engraving, and running continuously in the direction indicated by the arrow, will turn one set of pulleys in one direction and the other set in the opposite direction. The two loose pulleys being twice as wide as the fast pulleys, and the belt being somewhat narrower than the face of the fast pulleys, Q and S, if it be shifted to run on the large fast pulley, Q, its other turn will be on the small loose pulley, T; in this condition the pinion, O, connected with the large fast pulley, Q, will be the driver of the spur wheel, M, and give motion through the worms and worm wheels to the pinion below, which gear with the racks of the table, and will thus drive the uprights in one direction, which should be that of cut. If the belt be now shifted off the large fast pulley its own width only, it will run on the two loose pulleys, R and T, and thus give no motion to the worms; but upon shifting it still farther, until it drives on the small fast pulley, S, the uprights will be drawn back at twice the velocity with which they were carried forward. The driving belt thus runs continuously in one direction, it passes around a large pulley at one end of the limit of motion of the machine and over a small one at the other end; either of them may be made the driver. The main cutting tool, U, is carried in a slide rest, V, which is arranged in reference to the crosshead precisely the same as in ordinary planing machines, but provided with the improved tool-lifting device used in the Sellers' planing machine with moving table, which we shall engrave for a future part. The crosshead is raised or lowered by screws in the uprights, and has clamping screws to hold it fast at any desired height. The horizontal shaft, W, across the top of the uprights, which connects the two lifting screws by means of bevel wheels, has upon it a spur wheel, X, sliding on a feather, so that it may be thrown into or out of gear with one of the wheels belonging to the feed motion, and thus the power from the driving belt is used for raising or lowering the crosshead, the above-described friction clutch arrangement serving to disengage the main driving wheel, M, from the worm shaft, so that the frame may remain stationary while the crosshead is being vertically adjusted.

A very ingenious mechanism is applied to make the machine automatic in its backward and forward motion, and to readily alter its length of stroke to suit the work to be planed. Outside of the main driving shaft, H, in the right hand upright a hollow screw, *a*, is suspended in a nut, *b*, which is attached to the upright, and motion is given to this screw by means of spur wheels, *c c*, one of which is on the driving shaft, H, and the other on a sleeve feathered to the screw, *a*. The number of threads in the whole length of this screw is in excess to the number of revolutions the driving pinions will make in running the whole length of the bed. At both ends of this screw are clutch projections, which match with adjustable clutches, *d d*, placed one above and the other below the hollow screw on a vertical shaft, *e*, passing through the screw. This vertical shaft, *e*, has a thread cut on it of the same pitch as that of the hollow screw, and is held at its top end in a nut, *f*, fastened to the upright. The relative position of the two adjustable clutches on this long shaft determines the length of traverse of the cutting tool, as the hollow screw during the back and forward movement will be alternately brought in contact with the clutch stop at either end, and give a part of a turn to the shaft by means of a lever and link connection at its lower end; this shaft actuates a vertical rock shaft, *g*, imparting the required motion to the belt shifter on the top of the machine. This belt shifting mechanism is identical with that on the Sellers' planing machine with diagonal driving shaft and traversing table, to be hereafter described with the aid of the plate in preparation, and without which description would be scarcely intelligible. The double pair feed motion and the manner of varying the amount of feed in this machine are also the same as those in the latter machine, the only difference being, that in the present case the use of the feed motion is extended to a pair of vertical slide rests, *h h*, provided on the faces of the two uprights for side cutting tools, which tools are thus made self-acting in either or both directions.

The machine exhibited measures 8 feet in clear between the uprights, and 8 feet from top of bed to under side of cross girt; total length of bed casting 24 feet, one end of which is arranged for joining a similar length of bed, making its total length 48 feet. This will permit a stroke of 40 feet without running over the ends of guide ways in the bed, the slide on uprights having a length of 8 feet 6 inches.

We are not quite clear, in the absence of any actual trial, how far the moving head gear of this machine can be employed to plane, at one side or end of the tool slides, a portion of any heavy mass laid on the ground alongside the fixed table, upon which the mass is supposed too big to be placed. But assuming that the diagonal or cross strains upon the moving faces of the V's, D D, should not be found to involve any jerking irregularity of motion with the machine thus employed—and we should not strongly apprehend that it would—then we can say that in our opinion this planing machine, with its 40 feet cut, its facile alterability of range, its great width and depth of receptive power upon the fixed table, *and* its power of operating upon great pieces (as of framing, bridge work, &c.) placed outside the limits of the table, together with the economizing of space with which all these powers are accompanied, make this machine of Sellers one of the best designed planing machines that have yet appeared.—Ed.

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RECENT PATENTS.

MANUFACTURE OF FILE BLANKS.

William Gray, *Sheffield.—Patent dated* 22*nd October*, 1867.

This invention relates to the rolling of file blanks of all shapes and sizes required by the trade in lieu of forging the same by hand labour.

Fig. 1.

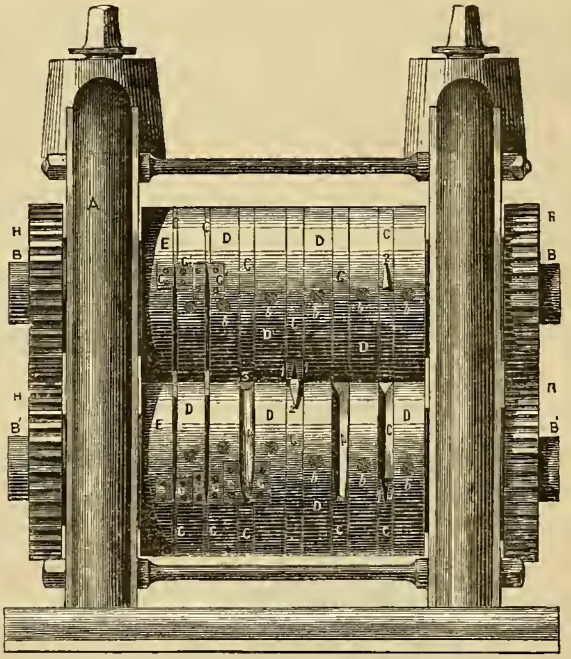


Fig. 1 of the engravings represents a front elevation of a rolling machine, with the improved appliances for rolling and shaping file blanks. Fig. 2 is a sectional elevation of the improved rolls, looking at right angles to fig. 1, showing a pair of steel plates adapted for rolling a parallel file blank. Fig. 3 is a detail of a pair of plates adapted for rolling or shaping an "entering" file blank. A A are the ordinary frames or standards of a rolling machine, and B B are the two rolls, to which are attached or fitted the several plates or portions of discs, C C, of steel, wrought iron, chilled cast metal, brass, or other suitable metal or alloy, and loose or movable collars, D D. In making up a roll suitable for rolling one or more patterns of file blanks, on to the body, B, of the roll, are slipped a series of plates or portions of discs, C, and loose collars, D, arranged alternately and pushed home so as to bear against the fixed collar or shoulder, E, formed upon the roll near one end thereof. F is a long key formed on each roll and fitting a corresponding key-way, *a*, made in each of the several plates and collars, C and D D, in order to prevent them from turning or getting loose on the rolls. These plates and collars are all kept in their places laterally by means of set or pinching screws, *b b*, fitted into the loose collars, D, and bearing against the body of the roll. Although at fig. 1 a pair of rolls is represented fitted up for rolling several different descriptions of file blanks, namely, flat, half-round, and three-square blanks, it is proposed to have the machine when at work fitted up for rolling only one description of blank at a time, and to change the plates, C, when a fresh pattern is required. Whatever may be the form and dimensions of the file blank to be rolled, the movable plate or portion of a disc, C, should be shaped or cut away at the periphery to suit such form, as shown clearly in figs. 2 and 3, where C C′ represent the top and bottom plates, each having a portion of their periphery removed for the production of a parallel file blank. In lieu of forming the shape or matrix of the file blank in the main body of the plate, C, it is preferred to employ a separate loose piece, *c*, which is readily adjusted by dovetails into the main plate, C, so that should this part become injured it does not involve the loss of the entire plate, but only the separate portion. Fig. 3 is a similar detail view of a pair of plates, C C′, formed for shaping what is known as an entering file blank, which requires to be tapered towards the point. In both these examples the piece of steel to be rolled into a file blank is inserted edgewise, or with the narrow edge upwards between the rolls. Half-round file blanks should be rolled breadthwise, the flat side being by preference placed uppermost, as shown in fig. 1. When rolling half-round and three-square blanks, the peripheries of the steel or chilled cast-metal plates, C, should be channelled, of course, to correspond. It will be obvious that any taper or reduction in the file blank can be produced in one direction by suitably shaping the plates, *c c′*, or C C′, as is shown in figs. 2 and 3, where the portion of the periphery from 1 to 2 serves to form the tang of the blank, whilst the remaining portion of the matrix from 2 to 3 in fig. 3, serves to produce the requisite taper towards the point of the entering file blank. Any lateral reduction or taper in a direction at right angles to the taper or reduction shown in figs. 2 and 3, is accomplished by fixing, by the aid of screws or otherwise, into the peripheries of the loose collars on each side of the steel plate, C, the matrix plates, G G, as shown in fig. 1; the contiguous edges of such plates being made to protrude over the periphery of the steel, wrought iron, chilled cast metal, or composition of metal plate; and to form the sides of the tapered or reduced portion of the matrix, H H, (fig. 1) are spur wheels secured to the necks of the rolls and geared together, in order to insure perfect accord between the two rolls when at work, so that the upper and lower halves of the cavity or matrix formed by the two rolls shall accurately coincide and produce a perfect file blank. When rolling a file blank the piece of steel is first passed through a groove which rolls it parallel, but imparts the proper cross sectional form to the blank and shapes the tang. The tang is formed by being nipped and partly sheared at the edges by the action of the matrix and die plates, 1, 2, (fig. 1), the matrix being formed by attaching the side plates, 1, to the plate, C, of the upper roll, and the die is formed by the projecting piece, 2, on the plate, C, of the lower roll; such projection fitting into the matrix and compressing the tang inside. The partly shaped file blank is then passed through a second groove with the tang foremost. On entering the blank between the rolls, the tang is pushed home up to its shoulder into a contracted portion of the groove shown at 3, (fig. 1), and the taper of the file blank towards its point is then produced by the tapering groove, as shown at 4 (fig. 1).

Fig. 2.

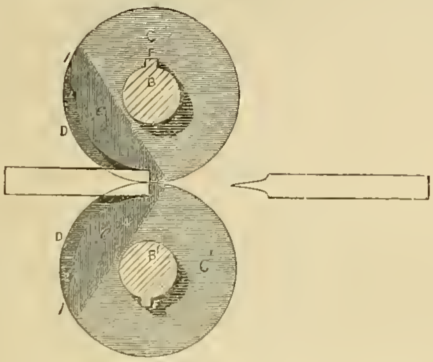
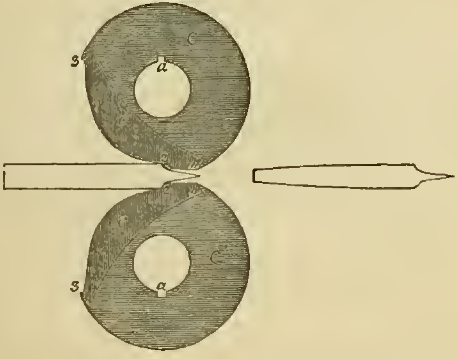


Fig. 3.



FURNACES FOR THE MANUFACTURE OF CAST STEEL.

E. P. Alexander, 47 *Lincoln's Inn Fields.*—*A communication from* Francis Ellershausen, *Ottawa, Canada.*—*Patent dated October* 1, 1867.

This invention relates to a process and furnace for manufacturing cast steel direct from iron ore, or from iron ore in connection with wrought iron.

Fig. 1 of the engravings represents a vertical section of the improved furnace, to which the inventor gives the name of "crucible furnace," and fig. 2 is a vertical section of the same taken at right angles to fig. 1.

O, represents the external shell of the furnace, which may be constructed in a rectangular form, of brick or other suitable material. A chimney, O′, of suitable height, is to be carried up from the furnace. The inner side of the furnace and chimney are lined with fire-brick, E, arranged in the peculiar form shown in the engravings. The inside of this furnace is divided into two distinct furnaces, A and B, one placed over the other and separated by a hearth or division plate, D, of any good refractory material. C, is a fire-grate placed near the bottom of the lower furnace, A, for the reception of the fuel. The division or hearth-plate, D, may be made of plumbago or other refractory material; and for the reception of this plate a cheek or recess is made in the wall, and a suitable allowance made for expansion on all sides. The plate will be of a curved or dished form, as shown in figs. 1 and 2, and will incline downwards about half an inch towards the point of discharge. F, is an aperture formed through the shell of the furnace, and situate about two feet above the hearth-plate, D. Through this aperture is introduced the charge, consisting of fuel and ore, into the upper furnace, B, for the blooming process. G, is the blast-

Fig. 1.

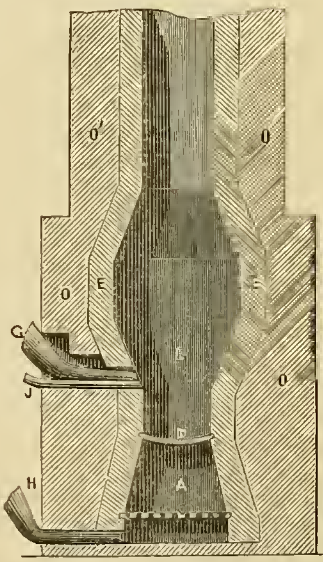
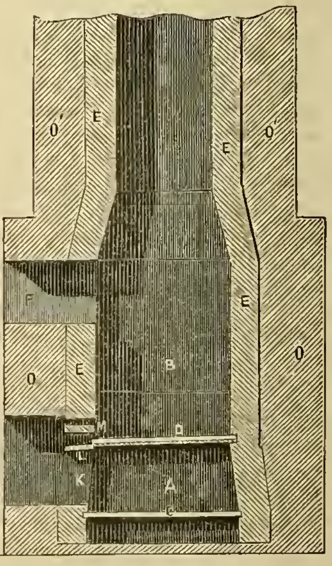


Fig. 2.



pipe of the upper furnace, entering the same about ten inches above the hearth-plate, D. H, is the blast-pipe for the lower furnace, which pipe enters the furnace below the grate bars, as shown in the drawings. J, is a pipe or channel for introducing the molten cast iron, or carburized compounds of iron, into the upper furnace, B; this channel leads from the hearth of an ordinary blast furnace, and may be made of clay. K, is the feeding opening or door of the lower furnace, for the introduction of fuel into the same. L, is a discharge hole or aperture for the molten metal, of about one inch in diameter, situate at the lower end of the hearth-plate, D. M, is a hole for the escape of the slag. Having thus described the construction of the improved furnace, the mode of working the same may be described as follows:—

The furnace having been arranged in the manner described, the upper furnace, B, in connection with the hearth-plate, D, forms a retort or crucible, to be heated in the inside by charcoal or pure charred peat to a sufficient extent for the blooming process; whilst it is also heated on the outside, or beneath the bottom or hearth, D, by the fire of the lower furnace, A, which is fed with fuel adapted for giving an intense heat. Combustion in both furnaces is maintained by the blast-pipes. After both of the furnaces are heated sufficiently, there is introduced through the channel, J, such a proportion of molten carburized iron into the upper furnace as is required to produce a given quantity of cast steel by the union with wrought iron (for example, 20 per cent. of highly carburized iron, smelted with 80 per cent. of wrought iron, will give cast steel of about 1 per cent of carbon). The process of blooming iron from iron ore in the upper furnace is now to be commenced, and such a proportion of blooms of iron have to be sunk in the bath of the cast iron as is required to produce a given quantity of cast steel by the union with the carburized iron. Different qualities of cast steel may be produced by varying the proportions of cast to wrought iron. During the operation, the lower furnace is to be kept heated to a sufficient degree to maintain the metal in the upper furnace in a state of fusion. After the blooming process is over, the metal is drawn off and moulded into ingots as cast steel.

The manufacture of cast steel from iron ore in connection with wrought iron is as follows:—After the introduction of carburized iron into the upper furnace, wrought iron is smelted in the same, with the addition of pulverized iron ore, in such quantities that the decarburization of the smelted wrought iron is effected by the addition of the oxide of iron (iron ore) before it sinks into the bath of the carburized iron first introduced. In this manner worn out rails of railways may be converted into cast steel, which, if desired, may be again manufactured into steel rails.

The inventor asserts that cast steel manufactured by the methods hereinbefore described, is both superior in quality, and is produced at a much less cost, than by any of the systems heretofore made use of.

REVIEWS OF NEW BOOKS.

Der Electro-Magnetismus, insbesondere als Triebkraft sowie mehrere neue Electro-Magnetische Maschinen, Wagen und Locomotiven. Von Dr. F. F. Roloff, &c., &c. Berlin, 1868. 1 vol. 8vo, with 8 Plates.

This is a clear and able account of, we cannot say nearly all, but of a great deal of what has been done, chiefly abroad, in attempting to bring the mechanical energy developable from the electric current into use, for one purpose or another, as a more or less direct motive agent. There are a good many who still cling to the notion that zinc, or some equivalent for it, can be oxidized or otherwise combined, so that the result in work, after transmutation from chemical into electric, and thence into dynamic energy, can be made to compete commercially with the oxidizing of coal in combustion, where the transmutation of potential energy is through heat; and those who do, do so in the teeth of demonstration. But while it is, perhaps, as certain as any physical fact can be, that this is impossible, it remains a truth that there are a certain number of special or peculiar ends, for the mechanical accomplishment of which electro-magnetic power may present special, positive, and real advantages. This is likely to be most true where the nature of the work required is that of an intense pressure acting through a very limited range, and that at the final working point, and of an alternating character; such, for example, as the work demanded from a printing press or an embossing press. We do not, however, purpose to enlarge upon this branch of mechanics here, for to treat of it to any good purpose it must be treated at length, and beginning at the right end, as is done in this little work of Dr. Roloff's, in which our readers who may be specially interested will see some designs for electro-magnetic machines, as queer as they are unlikely, but at the same time may gather a clear notion of all the physical bases upon which, to be of any use, such machines must be designed, no matter what may be the complexity or the variety of their parts.

Les Houillères en 1867, d'apres les Documents de l'Exposition Universelle. Par Amédée Burat, Mining Engineer, &c., &c. 1 vol. 8vo, text with atlas. Baudry, Paris. 1868.

This work may in some senses be viewed as a supplement to M. Burat's great work descriptive of the coal-fields and works of France and of the world, which has now some time been published, viz., in 1866.

He has taken advantage of the vast amount of geological, technical, statistic, and other information, either produced, or to be had by one prepared to take the trouble to ask for and obtain it, at the late Paris Exhibition, to collect and compile this work, which may be said to give the most recent and the largest amount of information, up to the end of last year at least, as to the state of the wrought coal-fields of Europe and the methods by which they are wrought.

The coal-fields passed in review as to their circumstances, geological and commercial, &c., are those of France, Belgium, Germany, Austria, and England; and the methods in use for working these are then briefly described and discussed. In this is included notices of the more recent proposals or trials as to mechanical or other improved methods of ventilation, shaft-sinking, and handling the won coal, both underground —as to which so much has been within a few years achieved in the north of England, in relation to the employment of mechanical haulage —and at the bank.

The work concludes with the discussion of a number of points or of circumstances in the condition of French coal working, which press heavily and discouragingly upon that national industry. Amongst these, want of ramified and abundant railway communications to the pits' mouths is given great prominence. M. Burat also ably exposes the continuance of an absurd old law in France, that no underground working can be driven within less than 100 metres of any house, village, or *walled inclosure of any sort.* This he shows in many thickly occupied districts, amounts to absolute prohibition to working the coal beneath at all. No such prohibition exists in Prussia, or with us in England; it has been, or is being, abandoned in Belgium, and surely ought to be so in France. The common law sufficiently protects the surface occupier in those cases against all substantial damage.

Essai Géologique sur le Jura Suisse. Par Dr. J. B. Greppin, &c., &c. 1 vol. small 4to, with coloured plates. H. George, Bâle. 1867.

This is an exhaustive monograph of the topographic geology and palæontology of a large portion of the great Jura ranges, and all we need say of it here is, that those of our readers who purpose to make that part of Switzerland the site of their holiday tour for this year, and who have sufficient preliminary knowledge to fit them for the companionship of Dr. Greppin, cannot do better than to accept here his guidance, in a work full of detailed information such as none but a local geologist can produce—easy to carry, and very low in price.

We may remark as a curious fact, that the admirable geological tourists' guides, of which so many have been published in Prussia by Baedeker, appear to be nearly unknown in England. Could not that enterprising publisher give us English translations, or permit others in England to do so? The little volume on the Eifel extinct volcanic region of Rhenish Prussia, is one of the best geological guides we have ever met with.

Der Schweizer Fön, nachtrag zu Eiszeit, Föhn und Scirocco. Von H. W. Dove. Berlin. 8vo pamphlet. 1868.

This pamphlet, which connects under the play of one set of cosmical forces some of the most remarkable phenomena of wind known to meteorology, and upon a true physical basis, will be of interest to at least one class of our readers, viz., the hydraulic engineers, into whose calculations of water-yield from given areas the influence of wind must always enter as an important element. The pamphlet otherwise is addressed to the pure or scientific meteorologist only, and has that amount of interest and value to be expected from the name of its illustrious author.—Ed.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

FLOATING DOCK AND BATTERY COMBINED.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—Some time back you gave some improvements I sent you relative to a navigable floating dock, constructed so as to steam out to its destination. I now take leave to forward a rather novel design in such structures, namely, a convenient dock suited to lift for repairs the heaviest vessel we have as yet constructed for Her Majesty's navy. The importance of such docks for foreign stations I think no one can dispute, being serviceable in any sheltered situation where there is water of sufficient depth to float them. As these docks are costly structures, and as we must have fortifications to protect our shores, why not utilize the large platform these docks afford by placing within them the heaviest guns we can make, thus making them a formidable arm of war to keep off the foreign invader? The drawing shows the original form, as adopted by the late firm of George Rennie & Sons, being the simplest mode of construction possible; and when such docks are not required to move from place to place, probably it is the best form, notwithstanding they are not navigable, and in this design the dock is simply moored in the most convenient situation in a barbour, and the end or mode of warfare adopted. By reference to the drawing it will be seen I have placed the battery between the basement and top chamber, and indented the embrasures, so that the guns can be fired at the various angles, as shown by the dotted lines, the sides of the dock being quite parallel, except the gun-rooms, as shown in the plan; indeed, the whole of the sides can be made quite parallel, and the structure traversed by suitable mechanism, so that the mooring chains are slackened on the one side, and hauled taut on the other, the back end moored as it were on a pivot, steam machinery being of course adopted. Thus the front would be hauled from side to side, so that each broadside would bear on the enemy, the bow guns firing all the time. Screw propellers, or even the unfortunate hydraulic, could be arranged so as to propel the structure from side to side. But I consider the end-on fire is better, even although it is more difficult to construct. I consider the water line as shown is more than sufficient to lift a vessel; but I have fitted the end with a caisson, so that by leaving a good body of water in the basement the centre of gravity is kept well down when docking a vessel or using it a as battery, the water inside of the dock protecting the structure in a great measure from vertical fire. The gun-rooms and top chambers are made perfectly watertight, the former having airtight doors covering the port holes, so that when the dock is sunk no water can enter the gun-rooms, the chamber underneath the guns, or the lower part of mid chamber; the water simply flows in as the dock is sunk, and flows out as it is raised; thus the water is simply let into the basement to sink the dock, and pumped out to raise it, along with a vessel inside dock, in dock proper.

Fig. 1.

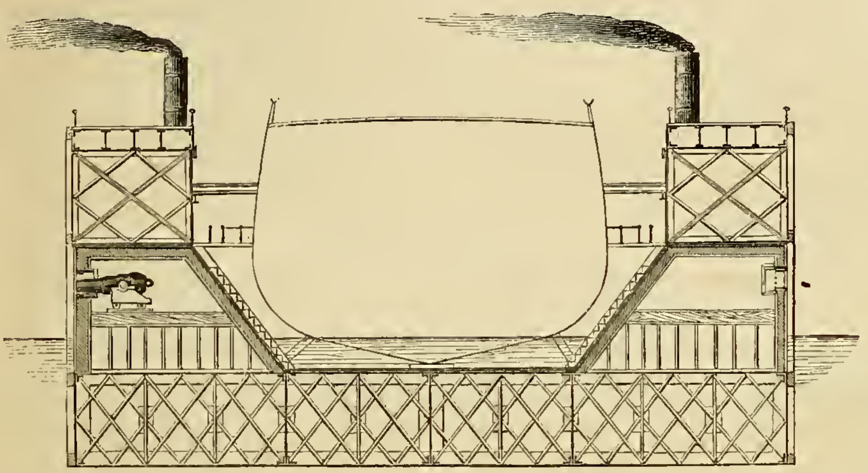


Fig. 2.

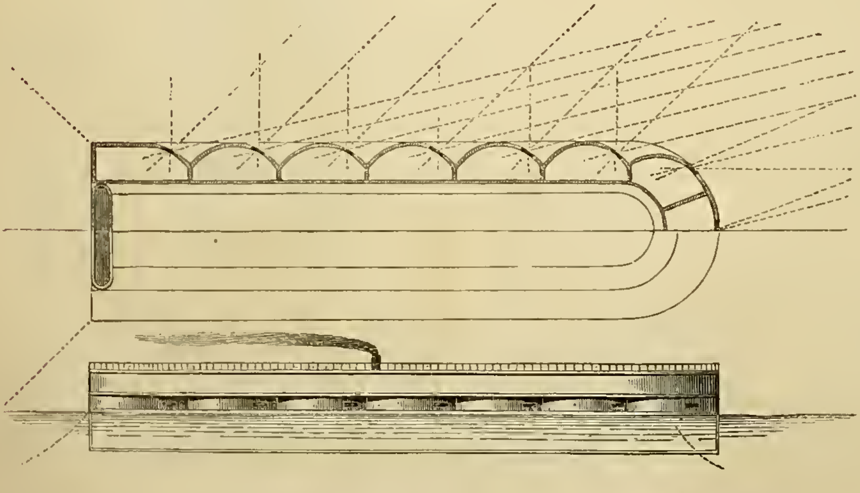
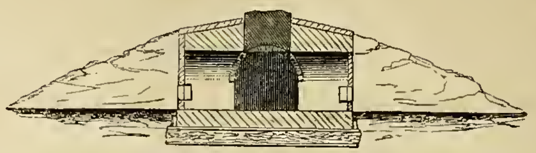


Fig 3.



I will not go into further details at present, but trust I have shown a method of protecting our mercantile marine in time of war, and having the means of docking them, to repair any casualties they may have sustained in the skirmish.

I am, yours truly,

JOHN G. WINTON.

P.S.—"As it is as well to hit two birds with the same stone, if possible," I would ask, when the end-on fire is so much approved of for ships of war, if it is recognized for land fortifications? It seems to me equally as good for the one as the other. We should present the smallest surface to the enemy; and should he be desirous of showing a bold front, we should have the means of giving him a warm reception. The annexed sketch conveys my meaning. The central arch runs the entire length of the fortification, with suitable arches for each gun-room: it may be armour plate. The top is covered over with earth to a suitable depth, with embankments at the end, so as to protect the entrance into the fort. The armament should be so disposed. Guns of the heaviest calibre placed in front are far more powerful than can ever be carried on board ship. Thus we keep the enemy at a distance, his shot having no effect on our weak point, if a circular front can be termed weak. Drop a shot from the first tier of side guns (a small bore being preferable), and drop it so that he may consider it safe to attack our slanting broadsides; and having thus enticed him within range of the small gun, yet let him consider that his armament is more powerful than our broadsides, he will risk the small gun, and approach nearer; then let loose guns of equal calibre to the front ones, and I think the small gunboats and such craft, that are advocated for protecting our harbours, or assailing a fort constructed on this principle, would be merely cockle shells in comparison.

J. G. W.

13 Gladstone Street, 12*th May*, 1868.

M. DE TAURINES' WEIGH-BRIDGES.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—I have been greatly interested by your remarks in your May number upon M. De Taurines' weigh-bridges. I use some, and am in want of more of these weigh-bridges for weighing bales of tow, and also carts, and would feel greatly obliged to you if you would inform me if these weigh-bridges are made for England to weigh cwts., qrs., lbs., &c.? I would like to have one to weigh up to half a ton, but would want to know the cost, and whether you think I could rely on it.

If what you say be borne out by experience, they will be an immense improvement; and if there is anything in them I should like to reap the benefit of it. Your attention will greatly oblige,

Yours respectfully,

ROBERT DEMPSTER.

Newry Spinning Mills, 12*th May*, 1868.

[We do not think that Mons. De Taurines has made any attempt to introduce his weighing machines into England. The general feeling in France, based on the experience of British prejudice and slowness, is against such attempts. Our correspondent, however, can readily obtain a machine from Paris, and the graduated dial can be changed with ease from kilogrammes to pounds, or he may just as easily weigh in kilogrammes (to which we shall all come in the end), and convert to pounds and ounces by a small table prepared for his own use.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF MECHANICAL ENGINEERS.

DESCRIPTION OF THE PAYING-OUT AND PICKING-UP MACHINERY EMPLOYED IN LAYING THE ATLANTIC TELEGRAPH CABLE.

By Mr. George Elliot, of London.

(Continued from page 61.)

Fig. 16.—General arrangement of Machinery in the *Dix Decembre*.

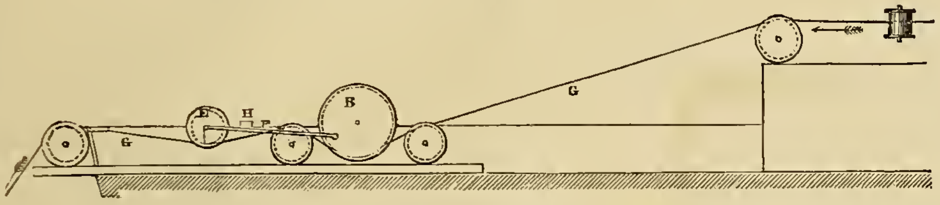
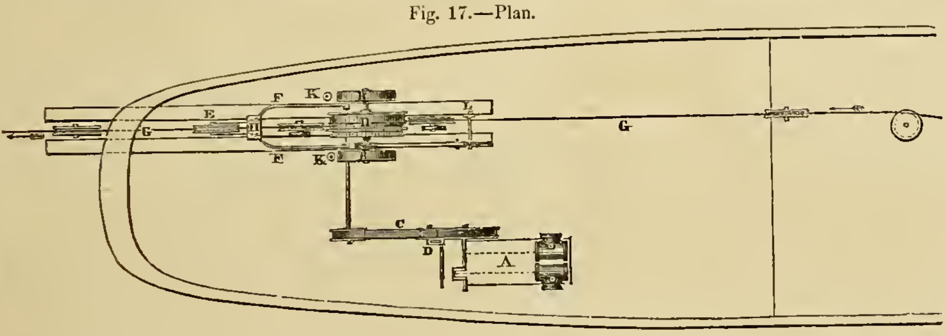


Fig. 17.—Plan.



The process for grappling was as follows:—The exact line of the cable having been marked by a couple of buoys put down by nautical observation, the ship was brought into a position about 3 or 4 knots north or south of this line, according to the direction of the wind and current, so that the ship might be drifted slowly across the line of the cable. The new cable of 1866 had been laid at a distance of about 30 knots southward of the line of the old cable, so as to avoid all risk of injury in the process of grappling for the old cable. In a depth of 1900 fathoms (nearly 2 knots), about 2200 fathoms length of grapnel rope with the chain and grapnel as before described was lowered with great care, taking about an hour or an hour and a half for the purpose. Whilst the grapnel was being lowered, accurate observations were continuously taken of the indications given by the dynamometer; and the grapnel striking the bottom was almost immediately indicated by a diminution of weight, as it and the chain weighed rather more than half a ton. About a couple of hundred fathoms of additional rope were then paid out, and the dynamometer from this time was most strictly watched; averages of the indications were taken every few minutes, and many hours frequently passed before there was the smallest change in these averages. It was interesting to observe how steadily these averages remained at about $8\frac{1}{2}$ to $9\frac{1}{2}$ tons, dependent upon the length of grapnel rope out, and the strength of the wind and current. An indicated rise of 5 cwts. was generally considered satisfactory evidence that the cable was once more hooked, and this seldom proved wrong; no attempt, however, was made to haul in the rope until the strain rose 2 tons above the average. As soon as a strain of $10\frac{1}{2}$ to 12 tons was observed, the ship was brought up by her engines to ease the strain, and the operation of picking up commenced; the strain then generally rose to about 14 or 15 tons, and continued at this amount until the bight of the cable was raised off the ground, after which time it gradually lessened. The attempt was once made to raise this bight direct to the surface without assistance from the other ships, and it proved successful, the cable coming a few feet above the water with a strain of about $6\frac{1}{2}$ tons. There was, however, a heavy swell on at the time, and the pitching of the ship broke the cable through.

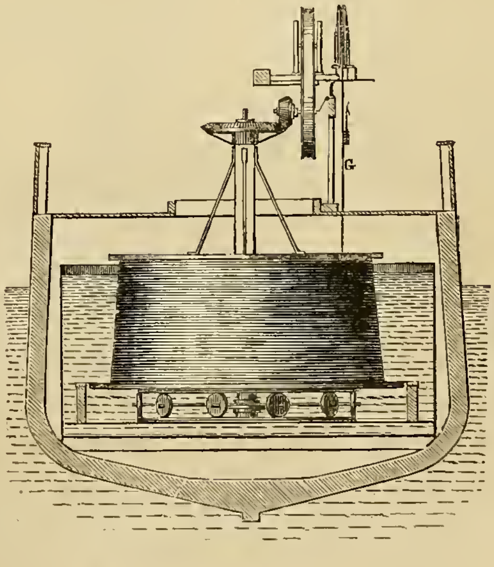
After many ineffectual attempts, the cable was at length successfully raised in the following manner. It was hooked by the *Great Eastern*, and the bight being raised about 900 fathoms from the bottom was buoyed there, as shown at B in fig. 6; the buoy attached was of the largest size, weighing $3\frac{1}{4}$ tons, and capable of supporting a weight of 13 tons. The *Great Eastern* then again grappled for the cable about 3 or 4 knots westward at S, and again found it; the *Medway* found it at the same time at M, about 2 knots westward of the *Great Eastern*. The *Great Eastern* then commenced hauling in, signalling to the *Medway* to do the same, and to break it if she could not bring the bight to the surface; this she accordingly did, the cable breaking about 200 fathoms below the surface. The *Great Eastern* in this manner had a loose end of about 2 knots to the westward, and had immediately a much reduced strain to contend with. Ultimately the end was successfully brought on board, the electrical circuit to Valentia was once more established from the ship, and the movement of the small speck of light on the galvanometer scale by the current received from Ireland indicated the success of the undertaking. A shout of joy spread through the ship, the guns bellowed out the welcome news to the other ships; and the anxiety of nineteen day's continuous trial, which had culminated in an intensity that was most significantly betokened by the oppressive silence whilst the end of the recovered cable was being tested, now gave way to universal cheering and excitement.

The recovered end was speedily spliced on to the remaining portion of the cable coiled in the tanks on board; and the ship was soon slowly proceeding onwards again with her head to the west. The paying-out machinery was from that moment all that possessed any interest; the picking-up dynamometer, which had been so constantly watched, was left deserted; and the hum of wheels, jockeys, and drums, was the sound most welcome to all on board. This fortunately continued without interruption until the ship's arrival the second time at Heart's Content, Newfoundland, thus completing the laying of the remaining 680 knots required to finish the original cable of 1865.

Specimens were exhibited of the new cable of 1866, and of the recovered cable of the previous year, with the grapnel rope by which it was picked up, together with the original charts of the laying and picking up, which were lent for the occasion by the kindness of Captain Sir James Anderson.

Mr. C. W. Siemens considered they were much indebted for the very interesting and valuable particulars given in the paper respecting machinery which had been successful in achieving such an important work as the laying of the Atlantic telegraph cable, and which appeared in all its details to have been most carefully arranged. In the previous expedition of 1865 there was no doubt that a great mistake had been made in having the picking-up machinery separated by a distance of more than 600 feet from the paying-out machinery, the two being at opposite ends of the great ship; and this he considered had caused the loss of the cable in that attempt. There was no occasion, however, for the use of separate machines for paying out and picking up, and machinery had previously been designed by himself for serving the double purpose of paying out and picking up (shown in figs. 16 to 23), which was made by Messrs. Easton and Amos and fitted on board the *Dix Decembre*, a French telegraph ship that had done a great deal of actual service in laying and picking up telegraph cables in the Mediterranean. The engine, A, figs. 17 and 19, was placed on deck near the paying-out gear, B, at the stern of the vessel; and the machinery was driven by the strap, C, tightened by the hand lever, D, so that it could be thrown out of gear at any time. By this means he had frequently reversed the action of the machinery from paying out to picking up within only a minute or two, which he considered was a point of special advantage in such operations, by admitting of readily hauling in the cable for examination or repairs; for if any accident happened to the cable in paying out, such as any deficiency occurring in the electrical tests, it was most essential that there should be facilities for picking up the cable immediately and examining the injured place. In picking up by this arrangement, the vessel had of course to be drawn backwards by the strain upon the cable in being slowly hauled in; and in the case of a head wind this strain was diminished by working the ship's engines slowly in the backward direction. The *Dix Decembre* had been largely employed in picking up the Port Vendre and Minorca cable and

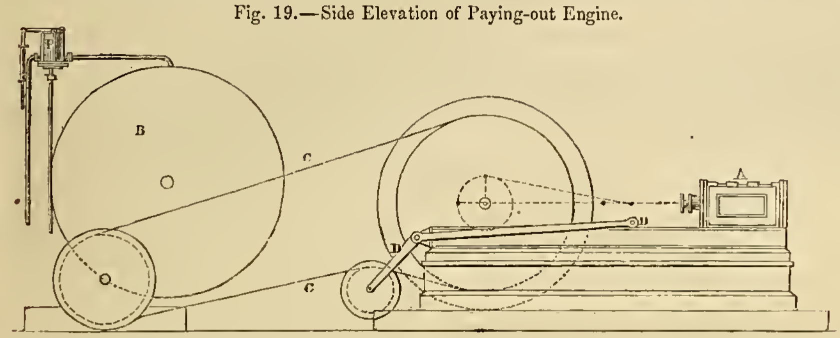
Fig. 18.—Transverse section through tank.



other old Mediterranean cables, hauling the cable in at the stern, with most satisfactory results. If, on the contrary, in order to haul in the cable it had to be taken round along the whole side of the vessel from the stern to the bows, there was very great risk of injuring the cable, or of losing it altogether, as occurred in 1865, because during the whole time of making the change the vessel was in effect riding at anchor upon the cable. He could only suppose that that mode of procedure arose from the old notion of sailors that the bows of a ship were the proper place for taking in a cable, because the anchor rope was always taken in at that end.

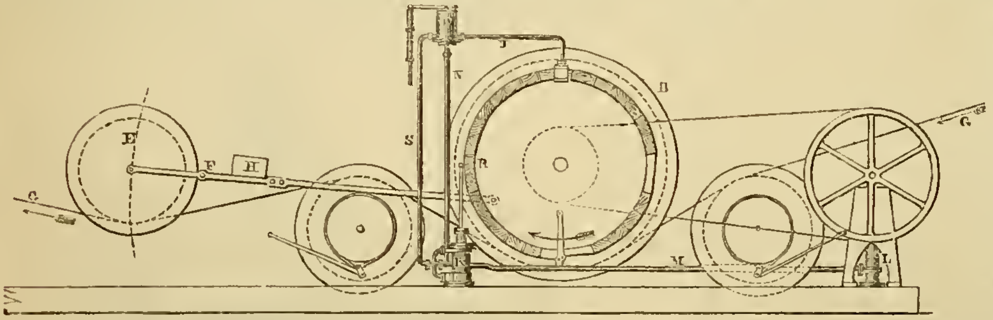
In paying out a cable, the dynamometer for showing continuously the strain under which the cable ran out was a most essential instrument, and in the arrangement described in the paper a weighted pulley working between guides rested upon the cable midway between two carrying wheels over which the cable passed. This construction, however, he thought was not so free in its action as the arrangement shown in fig. 20, which he had adopted and had found completely successful, having the weighted pulley, E, carried at the extremity of a lever, F, so that it rested freely upon the cable, G; the lever was loaded either by a weight, H, or by springs, the latter being preferable on account of their greater steadiness of action. A scale attached to the lever showed at all times the amount of strain upon the cable.

Fig. 19.—Side Elevation of Paying-out Engine.



In place of loading the friction breaks of the paying-out drum by means of dead weights, as had previously been done, with the addition on the *Great Eastern* of water cylinders to prevent undue oscillation of the weights, as described in the paper, he had adopted a plan of loading the breaks which he thought had an advantage in delicacy and certainty of action, by the use of a hydraulic cylinder, K, figs. 20 and 21, loaded by a constant pressure of water upon the piston, according to a suggestion originally made by Professor Rankine and embodied in the design of the machinery on the *Dix Decembre*. The supply of water to the cylinder, K, was maintained by the pump, L, fig. 20, driven constantly by a strap from the shaft of the paying-out drum, B; and the water being delivered along the pipe, M, communicated by the four-way cock, I, with the top of the break cylinder, K, and passed up the rising pipe, N, to the regulating valve, J, in the tank, P, shown to a larger scale in fig. 22. The cylindrical casing of the valve, J, had four V-shaped orifices, through which the water entering from the pipe, N, escaped continuously into the external tank, P, the rate of escape being regulated by the position of the plunger, J, forming a piston valve, which was loaded by a spring-balance, Q, like an ordinary safety valve. By this means a constant pressure was maintained upon the top of the piston in the break cylinder, K, and the load upon the break, R, in paying out was thus readily adjusted by screwing the spring-balance, Q, to the desired pressure; while at the same time the load upon the break could never exceed the maximum to which the spring-balance was adjusted. The bottom of the break cylinder, K, communicated by the four-way cock, I, and the exhaust pipe, S, with the tank, P, but outside the regulating valve, J, so that the loading pressure was not conveyed to the underside of the piston in the break cylinder; and in order to allow of a slight amount of yielding in the hydraulic break, and to give it a sort of elastic action, the four-way cock, I, was itself made with a small hole through the plug, as shown to a larger scale in fig. 23, through which a constant small leakage took place from the pressure side into the exhaust pipe. The break, R, was rendered self-relieving by the lever, T, fig. 21, in the same manner as described in the paper. There were two of the friction breaks, R R, fig. 17, one on each side of the paying-out drum, B; and the two rising pipes, N N, from the break cylinders, K K, both entered under the same regulating valve, J, fig. 22, whereby the load was maintained always exactly equal upon both breaks. The water escaping from under the valve, J, into the tank, P, was delivered by a pipe, U, upon the top of each of the breaks for the purpose of lubricating them. When driving the drum, B, in the contrary direction, for picking up the cable, it was only necessary to reverse the four-way cock, I; and the pressure then acting below the piston in the hydraulic cylinder, K, slacked the break strap off the break, while at the same time the lubrication by the waste water from the tank, P, continued undiminished, so that the drum, B, revolved freely without the action of the breaks.

Fig. 20.—Side Elevation of Paying-out Drum and Dynamometer.



In the laying of the Atlantic cable he was glad to see that water-tight tanks had been adopted for containing the cable on board the *Great Eastern*, as that was a measure which he had recommended for many years, because it preserved the cable from injury and allowed of a system of continuous tests during the whole time of the laying. In addition to the water-tight tank containing the cable in flakes or layers, an arrangement employed for light cables in the *Dix Decembre* was to carry the coil of cable upon a circular turntable revolving on a set of live rollers in the water tank, as shown in fig. 18.

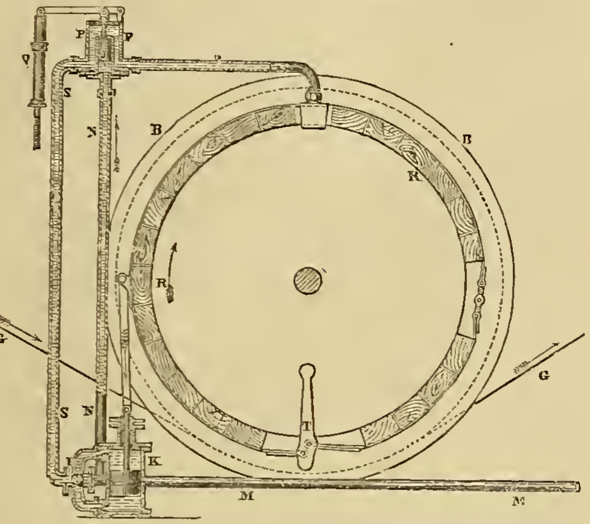
With regard to the grappling for the recovery of the cable of 1865, one fortunate circumstance connected with the Atlantic ocean was that its bottom appeared to be perfectly smooth and homogeneous. In the Mediterranean sea, however, where he had grappled a cable at a depth nearly but not quite equal to that of the Atlantic, the circumstances had been much less favourable in those respects; and the dynamometer was therefore by no means so steady, but was liable to fly up suddenly to perhaps 15 cwts. and drop down again to 4 or 5 cwts., so that it was impossible to decide with such accuracy as in the Atlantic whether the cable was taken hold of by the grapnel or not. The reason no doubt was that the Mediterranean had a rocky bottom, full of coral formations in moderate depths, and rocky even at its greatest depths; whereas the bottom of the Atlantic appeared to be almost perfectly smooth. Another circumstance highly in favour of the Atlantic cable was that there seemed to be no animal life at the bottom of the ocean; whereas in the Mediterranean, if such a cable covered partially with hemp were put down to the bottom, it would be utterly destroyed in a few months by animals breeding upon the cable and eating up the hemp, leaving the wires unprotected and a mere burden upon the tender core. This had been the case with the early Candia and Chios cable and with the Toulon and Algiers cable laid in 1859, both of which had become entirely useless after being down, the former only six months, and the latter only about eight months. On the contrary the specimen now exhibited of the recovered Atlantic cable of 1865, which had been down at the bottom of the ocean for twelve months, was evidently as perfect as at the time that it was laid, although its construction was the same as that of the Toulon and Algiers cable. On all acounts therefore there seemed every reason to hope that the Atlantic cable now laid would prove a durable one.

Mr. W. Fairbairn remarked that the laying of a cable across the Atlantic was one of the most important undertakings in ocean telegraphy; and having had an opportunity of inspecting the whole of the machinery a few days before the *Great Eastern* sailed on the last expedition, he considered it was most carefully constructed and arranged, so as to preclude any liability of mishap during the laying of the cable. The success that had attended the operation of laying the cable was mainly due in the first instance he thought to the use of the *Great Eastern* for conveying the cable, whereby the entire cable was contained in the hold of one vessel by means of the three tanks; so that by connecting these three lengths together in the vessel the entire cable was tested continuously during the whole process of laying it from Ireland to Newfoundland, and by this means any failure in the electric currents would have been instantly detected. The operation of paying out the cable had been admirably performed, as described in the paper, and the success with which it had been accomplished showed how well the machinery had been adapted for the purpose. Having made the experiments upon the tensile strength of the cable, and also of the grapnel rope, he had found the results most creditable to the manufacture of both. One difference between the previous cable of 1865 and the new one of 1866 was that the former was coated with pitch, while the latter was left clean; and it had been found that in going over the pulleys of the paying-out machinery the grooves became so glutinous and sticky with the pitched cable that there was great difficulty in keeping them sufficiently clean; the new cable, however, without the pitch, was paid out with the greatest possible ease, and this he thought contributed largely to the success of the laying. With regard to the destruction of the hemp covering by marine animals, even supposing the whole of the hemp were eaten off by them, the cable he believed would continue in complete working order, provided they did not attack the gutta-percha which formed the insulator. The outer covering of hemp appeared to him of very little importance or value after the laying of the cable had been accomplished, and so long as the insulator remained complete, he thought it would not be of fatal consequence if the whole of the outer covering were decomposed or eaten off. There appeared every reason to believe that the two cables now laid across the Atlantic, remaining perfectly quiescent at the bottom of the ocean, at so great a depth below the surface, and under such a heavy pressure of water, might continue in perfect working order for a great number of years.

Mr. J. T. Wright observed that he had been out to the Mediterranean a few months previously, and had had an opportunity of examining a portion of one of the cables that had been raised for repairs; and it was found that, though the marine animals had destroyed the hemp, the cable remained electrically perfect and efficient wherever not damaged by excessive strain upon the core.

Mr. C. W. Siemens said he had seen the hemp covering of a cable entirely eaten away, and even the gutta-percha indented about 1-16th or 1-8th inch, but beyond that point the action of the marine animals did not appear to go. With regard, however, to the safety of the cable when deprived of its hemp covering, although it might continue efficient if lying upon a perfectly smooth bottom and with the tensile strain perfectly equalized throughout its length, yet that would certainly not be the case in the Mediterranean, where he was satisfied that as soon as the cable had ever worn weak at any point it would break, because the bottom of the sea was so uneven that the cable hung unsupported in a great many places. He had seen pieces of Mediterranean and Red Sea cables which had evidently given way at points of suspension by the rusting of the iron wires; and wherever the cable had parted, the core had been elongated several inches, and had shown electrical faults.

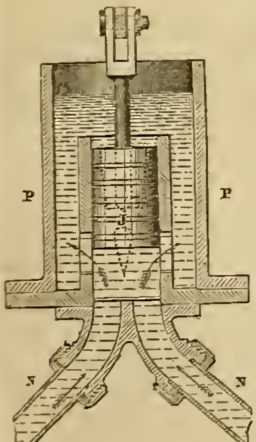
Fig. 21.—Hydraulic Break on Paying-out Drum.



Wherever the bottom was not perfectly smooth, the strains produced by the suspended portions of the cable must ultimately lead to fracture, if the iron wires became laid open to the action of rusting. So long as a cable retained its full strength, it was not indeed necessary that it should be perfectly supported throughout its entire length; but unless it were proved that the bottom of the Atlantic was so perfectly even that no portion of the cable would be in suspension, the continuance of the cable in working order must be dependent, he considered, upon the durability of the hemp covering protecting the iron wires from corrosion, which in the absence of marine animals might be for many years.

In addition to preserving the iron wires from rust, it must be borne in mind that the durability of the hemp covering was also essential to the strength of the cable, in consequence of the hemp acting as a packing to keep the wires at the proper distance apart. If the hemp were eaten away, the wires would be left like a loose cage round the core, and the latter would stretch and become faulty in consequence.

Fig. 22.—Enlarged Section of Regulating Valve.



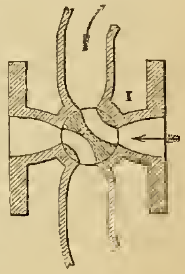
Mr. W. Fairbairn had no doubt that in situations where the bottom of the sea was irregular, as in the Mediterranean and other volcanic districts, sharp points of rock would be met with where a cable would be carried by suspension in the manner that had been described; and he suggested that in such cases, where there was a liability of the hemp becoming abraded or eaten away by marine animals, an exterior covering of wires should be employed without hemp, so as to assist in preserving the full strength of the cable unimpaired by time. In the Atlantic, however, the apparently level character of the bottom led to the conclusion that no such difficulties would arise in connection with that cable; and with regard to marine animals, although they had been proved to exist in other seas at a depth of even 2 or 2½ knots, it did not appear clear that any danger was to be apprehended at so great a depth at the bottom of the Atlantic. There seemed every reason therefore to expect that the Atlantic cable now laid would be as perfect after twenty or thirty years' work as at the present time.

Mr. E. A. Cowper thought there was no question that wherever marine animals existed they would eat away the hemp covering of such a cable as the Atlantic, and would even attack the gutta-percha of the core; and as the sea water would exercise a corrosive action upon the iron wires as soon as the hemp covering was gone, it would become a mere question of time in such cases how long the cable would last. It was clear, therefore, that in such a sea as the Mediterranean, where the bottom was so irregular, and where animal life was known to exist down to the very bottom, it would be useless to attempt laying down a cable of the construction adopted for the Atlantic; and for such cases he considered the construction of cable designed and laid down by Mr. Siemens was well adapted, having the layer of hemp placed inside the cable, surrounding the core, while the external covering was formed of a sheathing of copper strips wound spirally on, whereby the cable was completely protected from the action of the water or the attacks of marine animals.

In reference to the description given in the paper of the grappling and raising of the previous cable of 1865, as shown in fig. 6, it appeared that, after the cable had been first grappled and buoyed up at B, to a height of about 900 fathoms from the bottom, the *Great Eastern* grappled it again further westward and raised it to the surface at S, where the splice was made, and the paying out then commenced of the additional length for completing the cable to Newfoundland; and he inquired whether the state of the cable had been examined at the bight B, where it had been buoyed, and whether it exhibited any signs of injury from the grapnel pulling at it in that part.

Mr. F. G. Wynne said that he had been on board the *Great Eastern* during the paying out of the new cable, and afterwards on board the *Albany*, which grappled in concert with the two other ships. After the splice had been made at the point S, where the cable had been raised to the surface, the paying out of the additional length for completing the cable had been proceeded with at once, and no examination had been made of the bight B, where the cable had been grappled and buoyed, because the cable was proved to be electrically perfect; and there was no fear of injury having been occasioned to the outer covering, because the loose end brought up by the *Albany* showed only a very slight indentation where it had been hooked by the grapnel. The nautical observations taken in 1865 of the exact position of the broken end, though of great use in the first grappling for the cable in 1866, were not used in the final grappling, which was done 90 knots eastward of the first grappling; this was in order to avoid a deep depression in the bottom of the ocean, and also because the *Albany* had brought up a 2½ knots length of cable to the eastward of the place where the *Great Eastern* had first grappled and raised the cable to the surface; and the examination of this piece proved that, even if the cable had been successfully raised where first grappled, there would have been no communication with Ireland. The westward end of the length brought up by the *Albany* was found to have the copper conductor corroded to a length of about ¼ inch inwards from the end; and as this corrosion was no doubt due to the testing from Valentia, it showed that the cable must have been broken at that place in the previous year's operations, and the other end had no doubt been broken in the grappling of 1866.

Fig. 23.—Section of Four-way Cock.



In the paying out of the cable from the *Great Eastern* and the dragging with the grapnel, the successful working of the dynamometers was mainly due, he thought, to the steadiness of the ship itself; but even there the movement was so great when grappling in bad weather that it was often necessary to take averages of ten or twelve successive oscillations, in order to determine accurately enough the strain upon the grapnel rope. In the *Medway* and *Albany*, however, on account of the smaller size of the vessels themselves, the dynamometers used to jerk up frequently through the whole range of the index from bottom to top, with such violence as to force the water out of the top of the water cylinder and render it useless, so that it had to be replenished with water at frequent intervals, sometimes every ten minutes.

In the new cable now laid across the Atlantic, the hemp covering was not left plain throughout the entire length, but there were several considerable lengths of it that were tarred. During the paying out of the untarred portion of the cable, temporary accidents in the tanks containing the cable were not unfrequent, owing, he believed, to projecting ends of wire catching in loose portions of the hemp covering of the adjacent coil; but in consequence of the care and promptitude of the men in instantly catching the lifted coil, only the one serious accident occurred that was mentioned in the paper. Loose ends of wire were also frequently detected by the scratching sound they made in running through the paying-out machinery. No such accident, however, that he knew of occurred with the tarred portion of the cable, in which the tar seemed to close down completely the loose bights of hemp in the cable.

With regard to the question of animal life at the bottom of the Atlantic, he had seen three long conical shells, two of which were perfect, brought up from a depth of 2000 fathoms, having been entangled in the grapnel rope of the *Albany;* they were all apparently of the same species, but he believed there was nothing alive in them. It appeared that the grapnel rope must have passed through a considerable number of them, because the three brought up were within a few feet of one another on the rope. Specimens of the worm on which the codfish feeds were also met with at considerable depths on the grapnel rope; but these might have been caught upon the rope while hauling it up.

The President remarked that, having had to construct the picking-up machinery on the *Great Eastern* and the engines for driving it, which were non-condensing, he had considered it important to make provision for extra security against possibility of any undue strain ever coming upon the cable from any accidental increase of steam pressure in the engines, as they were of rather large power for the work they had to do. For this purpose he had added a very large safety valve upon the steam pipe, between the throttle valve and the slide-valve chest, and this safety valve was loaded by a spring to the limit of pressure of steam intended to be supplied to the engines, 20 lbs. per square inch; a very long spiral spring was used, in order to obtain a great amount of elasticity, so that if the boiler pressure ever rose beyond the limit of 20 lbs., the excess of pressure would not be able to reach the pistons of the engines, but would be carried off by this large safety valve.

He proposed a vote of thanks to Mr. Elliot for the paper, which was passed.

INSTITUTION OF NAVAL ARCHITECTS.

THE TREATMENT OF STEEL PLATES IN THE SHIPBUILDER'S YARD.

By T. A. Rochussen, Esq.

The use of iron for the conveyance of goods and passengers on roads, and the consequent application of large quantities of wrought iron to rails and bridges, stimulated a facility for the production of a material which, almost at the same time when railways became in use, entered into the construction of ships.

The iron manufacture of that period was limited to a comparative small number of makers, who, trained to good work, supplied a metal, the excellency of which we see illustrated by rails of more than twenty-five years' life on some of our leading railways, and the hulls of iron steamers, such as the *Lord John Russell*, the *Sir Robert Peel*, sailing from London, and others in the north, who, notwithstanding a hard-worked career of thirty years, still enjoy a green old age.

The railway system under the impulse of a very rapid development, encroaching chiefly upon landed property, fortunately found only one controller of its organization in the different Acts of Parliament regulating expropriation and compensation, and the infliction of a very slight and inefficient supervision of the Board of Trade, and was thus enabled to select the best material for the working of its traffic. It stimulated the production of the finest locomotive engines, and when these heavy messengers of commerce destroyed the iron rails upon which they ran, railways, as far as their finances would allow, substituted steel rails.

The traffic on land, therefore, accommodated itself to circumstances, and the genius of man rose to the requirements which man had created. The human being, born and living on *terra firma*, appears from time immemorial to have looked upon the sea as an element where existence was extra dangerous, and thus almost every nation, except the bold sailor population of Holland and Scandinavia, allowed itself, in the matter of shipping, to be guided and coerced by governments or by corporate bodies, especially invested with conventional authority, such as English Lloyd's, or French *Bureau Veritas.*

The interference of both, especially the former, has in its time done an immense amount of good; and, while defining equitable averages of sea risks, they have at the same time endeavoured, by the accumulated experience of generations, to establish wholesome rules for the construction of wooden ships, offering the greatest security to man and merchandise.

When iron entered into the construction of ships, the material was not well understood by those who, by force of habit, had to determine the mode of its application, but who were simply accustomed to the dumb strength of wood, viz., resistance to the pulling strain on a fibre, and thus sought in iron only *one* equivalent, that is, a high figure of breaking strain. This was fixed by Lloyds at 20 tons, and subsequently by the Admiralty following in its wake, at 22 tons per square inch with, and 18 tons across, the so-called fibre.

Never was the adage "of a little knowledge being a dangerous thing" more true than in the instance of this single Admiralty test. It was established in deliberate ignorance of the intelligent iron industry, not only of this country, but of Europe in general, at a time when the splendid qualities of such iron as Yorkshire, Sweden, and Westphalia produce, ought to have been appreciated, because they were known. It gave rise to the manufacture of an iron, responding to the demand for *one* element of strength only, to the construction of ships, many of which have gone down or broke up under circumstances where no injury ought to have been caused, more of which are still floating with the false hall-mark of a high class and seaworthiness; and finally this Admiralty test has failed to educate the shipbuilder into the knowledge of good material, and given him the temptation to use the cheapest and worst iron, provided it tested up to 22 tons.

It was but natural that common sense would at last emancipate itself from the trammels of absurdity; and, therefore, while those merchants who had simply an insurable interest at heart continued to own ships built of regulation test iron, there were others who, independent of insurance, sought security in the material of their ships, rather than in policies: and thus we find that, beginning with the large steamtugs on the Rhine, as early as 1851, private yachts, channel and shallow river steamers, steel was already recognized as the best material for shipbuilding, when the American Confederate war, and the consequent blockade running, called into life a fleet of steel steamers. These ships were built with a total disregard of the conditions of ordinary insurance: a sort of ocean-butterflies, the thickness of their plates bordered upon the bounds of imprudence; and yet, I believe, only one, the *Leila*, was lost in a terrific gale of wind going out of the Mersey.

While the yards of the Clyde and Mersey were full of blockade runners, it was natural that the material came under more general notice, and thus at that period several steel vessels were built for the ordinary long-passage trade, which, although classed A 1 Excellent, twenty years in the Liverpool book, did not, in the definition of Lloyd's, rank higher than iron.

It so happens, fortunately, that no official control has been exercised over the material of masts and other spars, and thus, until the owner had no interest in improving upon iron for the hull of his ship, he could with direct benefit to himself rig his vessel with steel spars, which, in the China clippers of modern build, are now almost universally adopted. It would be folly to waste time in demonstrating why a light and strong material should take the place of a heavier and weaker, or to calculate the time when steel in shipbuilding will receive its official recognition, as distinguished by various tests from ordinary iron.

It already takes part in the most important armaments of the country, and in this instance, at least, the administration of the War Office and the Admiralty, if not on a par with that of other countries, is more alive to improvement than the more pacific authorities. I am justified in looking upon steel as the material which our period requires, and will adopt as soon as the community is technically free to use it to the best advantage, and here we enter upon the consideration of the material itself.

We are aware that steel is made from different irons, by different processes, so it presents almost as many varieties as wrought iron; and whether made by puddling or Bessemering, every make will in time obtain a distinct qualification of merit, such as in iron we apportion to Sweden, Westphalia, and Yorkshire. Notwithstanding this we have to deal with the general properties of steel applying to all makes, which, if well understood, will facilitate its treatment in the builder's yard, as distinguished from the handling of iron; and the absence of this knowledge of the nature of steel demands the more urgently supplying, since even in this ball well-wishing friends have stumbled over bad material or good material badly handled.

We often hear, and probably with justice, that steel is not reliable, that it is not homogeneous, and people who have spent a life in successfully treating iron, point with scorn at a steel plate which has split or snapped under circumstances where iron would not have sustained any injury. Thus steelyards have snapped in the truss, topmasts split in the fid-hole, plates cracked on sharp curves, and, saving the possibility of bad material inherent to all human production, the quality of the steel may, for all that, have originally been unimpeachable.

Steel, as many a young beginner in life, had to be saved from its friends; the belief in its breaking strain was at first unfortunately based upon the knowledge of tool steel, and it was not uncommon to specify in construction steel equal to 42 to 45 tons per square inch. That metal, supplied by ambitious or sanguine makers, did not work well, or committed suicide after working, and the effect of such failures has taken some time to work off. The fault did not always arise from want of homogeneity, because of all the varieties of iron manufacture, that of making steel insures more than any other an even distribution of component particles. Having split upon the rock of hardness, and knowing what steel could not do, it seems to be agreed by makers and ship constructors, that we are within bounds of safety by exacting a tensile strength of 32 tons per square inch.

This mild steel is adapted to every purpose intended by the builder, viz., bending to curve, and punching, but with greater care than would be observed with iron, inasmuch that we have not the free command of heat which iron allows with impunity. And it is just this important point of heat which has to decide the part which steel can play in shipbuilding, and the careless application of which has been the primary cause of such mishaps as may have occurred.

Heating for the purpose of bending through rolls where the material does not receive any elongating pressure, under all circumstances, entails a loss of tensile strength both in iron and steel. But with steel we run two risks: either the steel may become overheated, and, slowly cooling after bending, remain very soft and weak; or on the passage of the heated plate from the furnace through the rolls, a keen draught of wind, a shower of rain, or dragging over wet ground, may chill the metal, and, while making it wholly or in part hard, render it unfit for a construction requiring elasticity.

Building yards are, as a rule, constructed for the requirements of wooden ships, viz., plenty of room for bulky timber. There is free access to wind and weather, and almost every operation of iron and steel is carried on in the open air. The bending rolls are seldom roofed over; the reheating furnaces are fixed from the back or sides; thus when opening the doors there is a rush of cold air upon the hot plate, which then getting a chill cracks when bending through the rolls, or when hammered to a curve. Above all things, it is therefore necessary either so to control the heat given in the yard within a limit which *cannot* be exceeded, or to dispense with heat altogether.

Previous annealing has been suggested as the sovereign cure for overheating hard steel, or as affording indemnity against the danger of cracking when steel is worked too cold in the building yard. But looking at this question from an economical point of view, it must be settled whether the shipbuilder is expected to erect furnaces sufficient for the annealing of a large number of plates, and devote attention to the careful issue of an operation on a metal to which he is a stranger, or is the annealing to be done by the steel manufacturer?

Experience teaches that the annealing of cast steel gun barrels, cannon, &c., in furnaces of from 10 to 18 feet long, with charges of from $2\frac{1}{2}$ to 7 tons, takes five to seven days. Assuming that ship plates from $\frac{1}{4}$ to $\frac{9}{16}$ inch thick, in sizes up to 30 feet long and 6 feet wide, will require only half-day firing, and a day and a half cooling down, the annealing of 300 tons of plates per week would entail such an extension of plant and labour as materially to affect the price of the steel, independent of which the annealed plate always has a rougher surface, unsightly to the eye, and decidedly to be avoided in a ship's skin. Annealing of large masses therefore being impracticable, the builder must have furnaces which cannot be overheated, or he must work the steel cold.

In order to settle both points I have conducted a number of experiments with 127 plates of all thicknesses, of the quality usually supplied to shipbuilders.

Collecting opinions on the Clyde and in England, I found that in the different yards, the same steel in one yard, heated simply to a temperature touchable by hand, in the other yard to a cherry red, was reported to yield the same results, and that therefore a low temperature, say of molten lead, would be sufficient for all purposes.

Operating with plates, equal to a breaking strain of 38 tons, and an elasticity modulus of 21 tons, the dipping into a bath of molten lead made no difference in the strength of the steel, while it worked well in punching or bending, and I therefore conclude that while *this* heat could not possibly hurt a good material, it may serve to let down the temper of hard steel, while the expense of a lead bath, involving scarcely any consumption of that metal, would be only a trifling increase to the plant of a building yard; the more so since the heat communicated by molten lead is instantaneous, though limited to an unvarying temperature, while a coal furnace is less certain, and the heating of one plate takes from eight to ten minutes. We now proceed to treat the same steel perfectly cold, taking care to reserve from every plate a length which is afterwards to be handled with a cherry-red heat. The cold plates, indiscriminately taken from stock during cold winter weather, withstood bending and punching to perfection, and I have put on the table pieces of a $\frac{3}{8}$ inch plate bent to a 9 inch circle, across the fibre; of a $1\frac{1}{2}$ inch steel plate bent to a 5 feet circle; of a $\frac{3}{16}$ inch plate rolled up like a sheet of paper; of plates punched near edge, all treated quite cold.

The corresponding halves of these plates, treated hot, of course permitted shaping and tooling equally well, but not better.

Looking at the subject superficially, it would have appeared that both heated and cold plates yielded the same result. But in order thoroughly to sift the question, the different plates were put on the testing machine, and gave the figures of merit illustrated by the diagrams on the wall.

In diagram 10 we have a bar or strip, L, with a real section, A, elongating under pulling strain to L′, and at the same time reducing its area at the point of greatest distress to A′.

A′ will be large, and L′ small, in hard metal, and *vice versâ* in ductile material, and thus the shaded portion of this diagram represents the ductility or power of steel to contract and elongate; in other words, the faculty to distribute strength to adjoining parts. The area of this shaded portion grows with the diminution of A′ and the increase of L′, and it determines exactly the value of resistance to ultimate breaking strain.

By assuming the sides of the plate to be straight instead of parabolical, we arrive, with sufficient approximative truth, at the formula

$$W\left\{L \times A - L\left(\frac{A + A'}{2}\right)\right.,$$

W being the breaking weight applied per square inch. But we have to consider an equally important element in steel constructions, viz., the amount of strength which the material still possesses after its elasticity has been overcome, and it is here that steel treated cold showed immense superiority over that which has been wrought at a red heat.

Fig. 1.

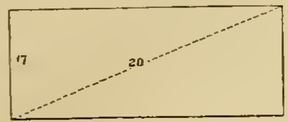


Fig. 2.

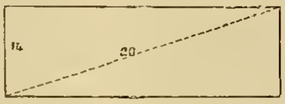


Fig. 3.

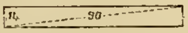
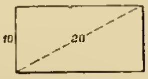


Fig. 4.



STORED STRENGTH = $DE\sqrt{(US)} - DE)$.

Fig. 5.

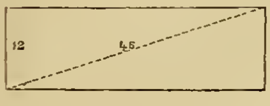


Fig. 6.

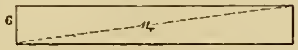


Fig. 7.

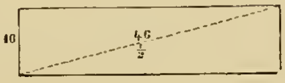


Fig. 8.

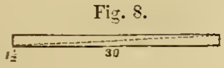
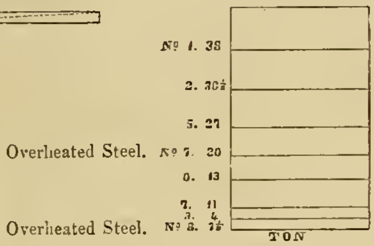


Fig. 9.



$$W\left\{LA - L\left(\frac{A + A}{2}\right)\right\}$$

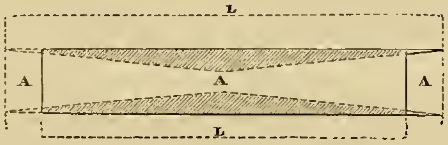


Diagram 1 represents cold-worked steel which lost its elasticity at 21 tons, and broke at 30 tons, showing a difference between the point of elasticity and breaking point of 17 tons.

No. 2. The same metal treated hot produced the respective figures of 20, 34, and 14 tons.

No. 7. The same steel purposely overheated, but gradually cooled, lost its elasticity at 15 tons, broke at 25 tons, with a contraction of area of 45 per cent.

No. 8. The same steel heated and purposely chilled, did not elongate till 34 tons, but broke at 35 tons with a contraction of only 2 per cent.

This tenacity of the steel temporarily to hold together after its elasticity has been conquered, is a useful adjunct of what I term *stored strength*, and represents the power which an injured material may still exercise in a moment of supreme danger. And in order to illustrate this stored strength more fully, I have added diagrams resulting from a few varieties of well-known iron. The red diagonal is the *ascertained* ultimate breaking strain in tons per square inch, and the parallelogram of forces sufficient to balance this resultant of destroying forces has for its one side the *ascertained* difference of elasticity and breaking strain, and the area of this parallelogram is thus represented by the formula—

$$DE\sqrt{\{US^2 - DE^2\}}$$

Thus No. 1 is the stored strength of cold steel No. 1, the ultimate breaking strain of which, with a contraction of 24 per cent., is 50 tons per square inch, a difference of elasticity of 17 tons, showing a stored strength equal to 833.

2. The same steel worked hot, contracting 30 per cent., with a breaking strain of 34 tons, gives an ultimate strain of 50, which, with a difference of elasticity, gives a relative value of stored strength of 672.

3. Hard East Coast iron yielded elasticity at 25 tons, breaking at 28 tons, with a contraction of 7 per cent., giving a stored strength of 89.

4. S.C. Crown iron, breaking strain 23 tons, with 12 per cent. contraction, difference of elasticity 10, gives a stored strength of 240.

5. Lowmoor iron, with a breaking strain of 27 tons, contracting 41 per cent., yielding elasticity at 15 tons, gives a stored strength of 528.

6. Very hard steel, not yielding elasticity till 39 tons, breaking with 45 at a contraction of 4 per cent. only, gives a stored strength of 276.

7. Overheated steel, before quoted, gives a stored strength of 440; and, lastly, 8. Heated but chilled steel leaves but a figure of 36.

And now, reconstructing all my parallelograms, as in diagram 9, on the base of the Admiralty test of 22 tons, we see at once how, for extreme power of endurance, the different metals occupy an order of merit—the mild steel at the top, the hard steel and iron lowest in the scale, showing that these metals, although possessing a nominal high tensile strength, have no power in reserve to resist a sudden excessive strain. This portion of the diagram at a glance exemplifies the metal which we can star with the blow of a rivet hammer, or snaps when a vessel takes an uneven bottom.

The thickness of the plates operated upon prove that every portion of a ship of 1500 or 2000 ton B M. (excepting rivets) can be worked cold; that heat is not required, may be injurious or even dangerous, and the weakening by heat of a few plates destroy the calculated strength of the ship, while at all times the fact of a steel plate working cold is a conclusive test of its good quality.

I have purposely abstained from analyzing the different methods by which steel is produced; sufficient be it to mention, that as the mere cost of melting crucible steel, both in England and in Prussia, is £9 per ton, the choice for the present lies between puddled and Bessemer steel. An experience of many years has taught to prefer puddled steel for plates, as possessing a greater amount of stored strength. On the other hand, angle bars, T, double T, and bulb beams of Bessemer steel, show a much higher figure of merit than Bessemer steel plates, and this arises probably from the fact that the metal passing through a series of rolling of different sections, gets a thorough kneading, and thus gains in homogeneity and ductility more than the plate, which is simply elongated from the bloom.

The Bessemer process certainly offers the advantage of satisfying a demand for very large blooms without weld, which the puddled steel-makers endeavour to approach by making puddled balls of from 2 to 7 cwt., and it is remarkable that blooms, made solid from these balls instead of piling hammered slabs, produce a material of immense strength.

I have laid on the table a specimen of this manufacture, taken from a cold bent plate, and testing up to 51 tons on the original area of fraction.

The time has now arrived when failures through heat need no longer occur; by manipulating all steel cold, the builder will effect a considerable amount of saving in fuel and furnace appliances, practically test in work almost every plate passing through his yard, and while emancipating himself from the risks attending rough and somewhat unskilled labour, unite with the steel-maker in producing a perfect structure.

THE TESTING OF IRON BY MAGNETISM.

By S. M. Saxby, Esq.

I have the pleasure of offering some remarks on a new method of testing iron, both as to condition and quality, by means of magnetism.

Its main feature is, that articles made of iron can be rapidly tested without damage to them or defacement.

Our only present means of ascertaining the condition of iron is one which often causes the evils we wish to avoid; we have only an imperfect and *destructive* system, and this only applies to quality of the metal, not to *condition*. By "condition," I mean the state of iron, whether as regards adventitious and accidental combinations, either chemical or mechanical, or with regard to faults and accidents in the process of forging, welding, and so forth.

My method is not yet fully developed; but so far as I have gone, enough has been proved to show that, in the hands of those who have more time and ability than I have, something might be done with the question of testing iron which might eventually place in the hands of manufacturers, and all persons interested in the extensive use of iron, a powerful means of avoiding accidents which frequently happen from the use of faulty material.

Some account of many of my experiments has already appeared in *The Engineer* and other newspapers. I will only refer slightly to one or two of them, rather selecting some points of the general subject which bear prominently on the application of my discovery to the wants of engineers, first explaining the extent to which I have successfully applied the test, and then explaining the mode of operating with it, adding a few remarks upon the general theory involved, but not more than is sufficient for the establishment of a firm foundation on which to rest my deductions.

To prevent misconception, it is better at the outset to declare that I do not profess (I never have professed) to be able to do more than test forged articles or castings, whether of iron or steel: whatever comes off the anvil (with an exceptional case or two, which I will explain presently) falls within the scope of my powers, but I wish it to be distinctly understood that hollow iron (iron purposely made hollow, excepting guns and small-arm barrels) have scarcely had any of my attention beyond a casual testing at the request of parties, whose anxiety to witness the possible limits of a novel and interesting operation, could scarcely, with any consistency on my part, have been treated with indifference. Nor am I consequently responsible for any unexpected results in my first attempts. It is one thing to study results of testing a bar of iron, the particulars respecting the preparation of which have been previously communicated to me, and in which known facts could be compared with results of testing; and quite another thing to *have* placed before me a suspected bar, the tamperings with which I had possibly reason to imagine to be the work of some of the ablest smiths in the kingdom, and devised on *purpose* to mislead and deceive me.

My experiences have been chiefly derived from these severe ordeals, which surely are better calculated to confuse and discourage than to instruct and explain.

In the former case, we can profitably and calmly investigate, but in the latter (and especially when we are expected to explain every step of what we are doing), even if we are accumulating facts, they are only heaped together without connection or time for arrangement. It is like the requiring of a student of a language who has not mastered his accidence to pass examination in its idioms.

But, Sir, I am not complaining; this is only for explanation, and to account for the slow progress I have made in magnetic testing during the past six months. I am, however, satisfied that if, under such disadvantages, I have been at all successful, the more deeply welcome to me ought to be these successes.

Passing over some disappointments I may have caused through inability to discriminate between clay and sand, and zinc and copper, &c., when filling cavities in bars which have been placed before me as solid (tricks which were really worthless, as impossible to occur in commerce), I may at once remark that in truth the general public, I had almost said the *educated* general public, know so little of the magnetic theory, that I have had to submit to decisions made by appointed judges whose total and confessed ignorance of the whole subject obliged me first to *instruct* them in the merest elements of magnetism.

Their decisions were, I doubt not, *honest* enough; but, from circumstances, must have been less just than honest. Perhaps this has been unavoidable; nor could I have submitted thereto except that, on the other hand, every man of real science who saw my work encouraged me to continue it, until at length it seemed wrong to be burdening my daily and hourly thoughts with what might lead to further expenses and a hopeless struggle.

I trust, Sir, the novelty of the subject will be accepted by this assembly as my excuse for having made these allusions to myself; it, however, too often happens that the unfortunate originator of what is new and useful must not expect success without some previous heart-burnings. That I am this day resuming my work is due to my having, since the formation of this truly valuable and national Institution, narrowly watched and admired, year by year, the spirit of honourable and above-board inquiry after truth which has so strongly marked its important discussions.

At our meeting in 1867 I heard an eminent engineer in this room declare impressively, that any one who could throw the least light upon the molecular condition of iron would confer a great boon on engineers and manufacturers; and this, Sir, is my additional apology for presuming to accept leave to read this paper.

Now, without occasion for entering into minute speculations as to the connection between iron and magnetism, it will perhaps suffice to assume (what I believe is fully admitted) that a mass of iron is an aggregation of distinct particles, each of which has polarity, that these particles are, among themselves, not in immediate contact.

I also assume, that what we call "pure iron" (as used in commerce) is that which is best adapted for general manufacturing purposes, so far as regards strength in every direction.

As an illustration of this I produce a sample of iron which, when pulled into this form cold, only broke at a strain of 43 tons per square inch; and that a test of the goodness and purity of iron is reasonably acknowledged to be its capability of being, like the specimen, tied up cold into a compact knot.

I also assume that tensile strength, however useful for some purposes, is but an insufficient test of what is called "goodness" in iron, inasmuch as it only indicates strength in one direction, and is not incompatible with brittleness.

I further assume that if each particle of iron has polarity, the *whole mass* which is made up of any number of such particles is a magnet—*inductively* so if the iron is pure and soft, and *permanently* so if in the state of steel or cast iron (the magnetic force having a decided connection with the presence of carbon). Hence I assert, that the old notion of magnetism existing only on the surface of iron is an error, and one that I will presently refute by direct experiment.

I assume still further that strength in iron is a consequence of a certain molecular condition, resulting from magnetic causes.

Now, the above form the groundwork of my system of testing, and, if conceded, enable me at once to proceed to illustration. But I would first suggest that it will be necessary to further admit that we never know when we have put a piece of iron or steel into a blast heat, as in a forge fire, whether it will come out thereof in an altered or unaltered condition. Last year, in this room, an eminent steel manufacturer, Mr. Rochussen, told us that he doubted whether in the process of forging, a shaft of steel as put into the furnace did not come out an iron one. His words were, "If in a *puddled steel shaft* when it is finished we have reached perfect homogeneity, it may also follow that by the frequent reheating which it has required in order to become a perfectly *weldable* mass it has been *reduced to iron.*" "If a shaft made on that principle is *sound, it is iron;* if it is steel, *it has all the elements of weakness from not being prepared.* Steel which will work well, which will equal iron in all its virtues, and which will excel in its working strength, cannot be made beyond 34 and 35 tons per square inch."

My experiments and observations on a small scale had convinced me of the same thing; and I arrived at my opinion in the following manner:

Steel may be described as *iron plus* certain other ingredients. Now, to remove any part of these "other ingredients, is to alter the character of the steel, and to remove them almost entirely, is to leave the iron (in a state of greater or less purity) in the place of steel; the "other ingredients" are the fluid particles which fly off under the blows of the hammer, and these blows when given at a welding heat are essentially a purifying process. On examination we find that the squeezed-out portions are not iron, because the specific gravity of iron is about 7·7, whereas these globules have a specific gravity of at most about 5·5, generally less; and, again, iron is malleable, but this oxide dross and impurity, as we may call it, is easily pulverized in an agate mortar. (I have a sample here in the state of an almost impalpable powder. It has not the tenacity of the metal iron at all.) So that the conversion of a shaft of steel into iron by the mere process of forging is what we might expect.

But admit this, and where are we? We are calling things by wrong names; we call that *steel* which was only *once* steel, and where we are *thinking* that we have the qualities of steel we have absolutely those of iron. And whether iron purified in the manner just alluded to *has* superior qualities remains to be proved. I can only say that Bowling iron (of which I shall say more presently), when subjected to my magnetic testing, shows many characteristics of steel.

With so great a variety, then, in the condition of forged articles, without at present *any means* (excepting a destructive one) of *knowing* this condition, or of detecting it, I submit that if I can offer you a ready method of examining iron articles, I may with confidence appeal to your kindness to receive my imperfect demonstrations with indulgence.

Let us ask a smith the quality of a piece of iron; if he may cut, or file, or break it, he will tell you its quality; but ask him as to its *soundness*, and he can only prove that by the testing machine. This is what I propose to remedy.

Before illustrating my practice of testing, it will save some time if I just call to mind one or two experiments in magnetism, which are, however, of so elementary a kind that I must apologize for naming them, except that they are necessary for my present illustration.

We are told that if we take a magnetized bar of iron or steel and divide it we shall have two separate magnets, each having its north and south poles; further divisions of these produce smaller and smaller magnets, until our powers of continued mechanical division are exhausted. It is easy thus to bring the mind to recognize the minuteness of the polar particles of a mass of iron as held together by means of such polarity.

That this "holding together" differs from what is commonly called cohesive force (and which belongs to all solids), and is a peculiar and distinctive characteristic of a few metals, such as iron, cobalt, &c., we can demonstrate.

There is the well-known experiment of suspending a series of small steel pins at the end of a powerful bar magnet. If that end be the north pole, the upper end of each needle will be a south pole, and the lower end a north pole. The pins are, of course, sustained in position by magnetism, which in this case acts as a cohesive force; whatever may be its nature, let us imagine its action to be analogous to that which exists among particles or molecules of iron when *favourably placed*, that is to say, when north and south poles *alternate*, as they do in the diagram; let us, in fact, for the occasion, view the *mass made up of bars and pins* as a solid, its parts as simply held together by cohesion. If we reverse or interrupt the force which connects the pins and bar, and we can easily do it, separation of the pins instantly follows; cohesion is destroyed: but the so-called cohesion which we are using in this case is *magnetism*—magnetic force—and *that* cohesion unmistakably constituted the tensile strength of the solid; therefore, who can say that magnetic force in iron is *not strength* in iron? This, then, is the main point.

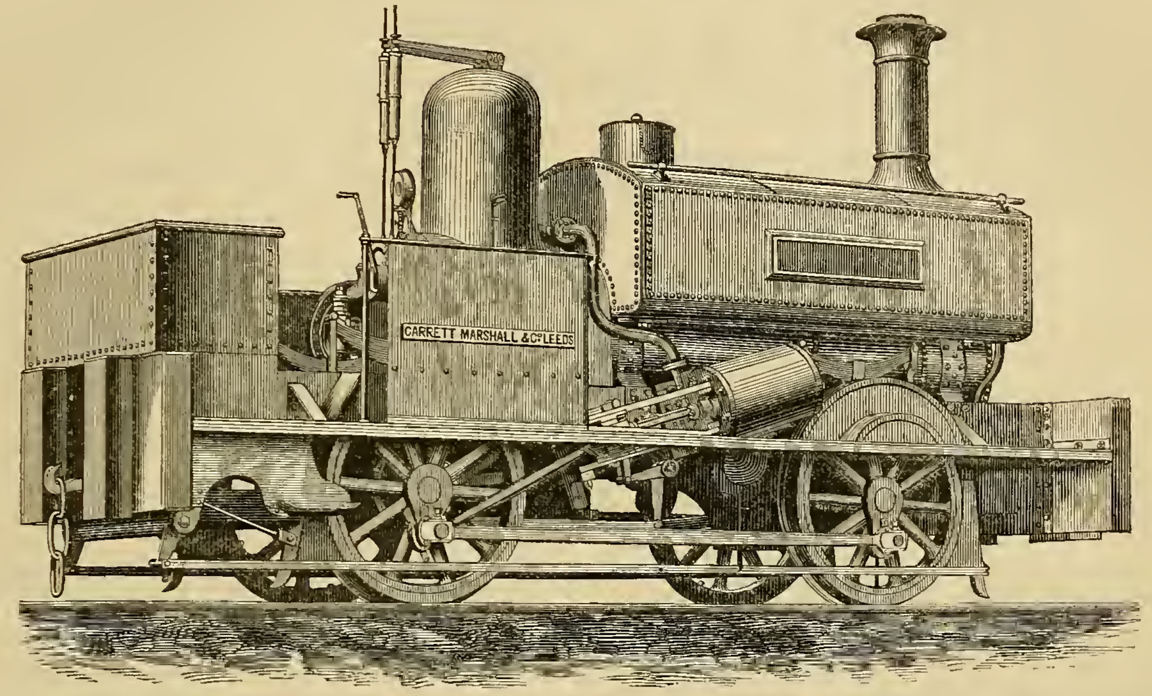
If we *interfere* with that favourable condition which is the element of strength in iron (viz., north pole to south pole, and south pole to north), we cause *weakness* in the metal. Hence my proposed axiom that "continuous alternate polarity in iron and steel constitutes *strength*, while its disruption or solution is *weakness*," and all flaws and faults are examples of such weakness.

(*To be continued.*)

MONTHLY NOTES.

Pellet Gunpowder.—The March *Army Circular* contains an appendix in the form of a list of changes in artillery *matériel*, small arms, and other military stores, with instructions relating thereto. These lists of changes will in future be issued monthly with the *Army Circulars*, instead of quarterly as heretofore. The present list contains an order that pellet gunpowder is to be provisionally adopted for all gun charges of 50 lbs. and upwards. The difference between this and ordinary granulated powder is due to the fact that the composition, after having been converted into "meal" in the breaking-down machine, is pressed at once into cylindrical pellets, instead of being made into "press-cake" and then broken into grains in the granulating machine. The pellets are formed by the meal being placed in a number of holes in a metal plate, into which closely-fitting punches (having projections that form a cavity in the end of each pellet) are forced by hydraulic pressure, adjusted to give the density required. This is the method by which pellets for fuzes and blank ammunition for Snider rifles have long been made in the royal laboratories. When the pellets are dry they are drummed for about half an hour with black lead to glaze them. The following are the particulars of the powder provisionally approved:—Range of density of the pellet, 1·65 to 1·7; diameter of pellet, 0·75 inch; depth, 0·485 inch to 0·495 inch; diameter of cavity, or indentation in end of pellet, 0·2 inch at top, 0·15 inch at bottom; depth of ditto, 0·25 inch; range in weight of the pellets, 18 grains to 95 grains, *i.e.*, about 78 to the pound. Pellet powder has been introduced in consequence of its exercising a materially less destructive effect on the guns than the present L. G. R. powder, than which it exerts a smaller maximum pressure. The repeated failures of 13-inch guns, only two of several of these pieces now remaining serviceable, was doubtless due to the destructive quality of this L. G. R. powder when used in very large charges; and, accordingly, the select committee, after instituting experiments with pellet powder, and comparing them with the results obtained in Russia and in America, recommended the introduction of this powder for the guns of the future, in which the charge would exceed 50 lbs. There are no guns larger than the 9-inch of 12 tons actually in the service as yet, though experiments have been made with a 10-inch rifled gun at Shoeburyness, and some 12-inch guns have been constructed during the last year; so that the introduction of the powder will be simultaneous with that of these heavier guns. We may therefore hope that no more large and costly guns will find their way to the list of those which have already yielded to the destructive action of our large grain rifled powder, which is far more powerful than that used by any other nation. Further experiments with pellet and prismatic powder are still in progress, and are likely to extend over a considerable period.—*Journal of the Society of Arts.*

Improved Direct-action Universal Tank Engine.—The annexed engraving is a side elevation of an universal tank engine, of which several are being constructed by the well-known firm of Carrett, Marshall, & Co., of the Sun Foundry, Leeds. The general arrangement of the parts, which are all easy of access, and favourably disposed, render these engines worthy of commendation. The example which we illustrate is constructed for a 4 feet 8½ inches gauge, but other gauges are made. The engine is provided with outside cylinders of 10½ inches diameter, by 16 inches stroke, firmly secured to the frame, and in "direct action" with the trailing wheels *behind* the fire-box, which are coupled forward to the leading wheels from the same crank-pin, the brake acting on one side of each of the four wheels which carry the whole weight, including the tank and coke-box. Thus the engine has all its working parts accessible, and of the simplest construction; the weight of the whole being equally distributed upon the two *straight* axles and their wheels of 3 feet 8 inches diameter, with no *overhanging fire-box* or *cylinders* to cause oscillation, and the centres of a convenient distance to pass freely round quick curves; as well as the total weight effective for ascending the steepest gradients with the heaviest loads. All the working parts are of wrought iron, and with ample wearing surface, and strong enough for a working pressure of 150 lbs. steam. The engine is furnished with a donkey-feed to supply the boiler. The tank is mounted above the boiler, but can be constructed to be carried underneath, when deemed advisable. There is an ample-sized coke-box behind, and firing room for the stoker, with the reversing link-motion and brake easily accessible. From the foregoing it will be seen why this engine runs free and steady round quick curves, with little friction. These advantages are said not to be possessed by any arrangement of six-coupled engine: or with a four-wheeled engine, having short centres. The general dimensions of these engines are—cylinders, $10\frac{1}{2}$ to 12 inches diameter; 16 to 18 inches stroke: 92 tubes 2 inches diameter = 362 square feet; fire-box = 48 square feet; total heating surface, 410 square feet; total weight, $13\frac{1}{2}$ tons.



Havre International Maritime Exhibition, under the Patronage of the Emperor of the French and the Prince Imperial.—The following official programme of this now nearly approaching exhibition ought to be known to our readers. After that of Paris of last year, the feeling is undoubtedly that all has been done in that way that is needful, if not all that is possible; yet a consideration of the subjoined programme will, we think, show that a small special exhibition of this sort may have real values not possessed by one of those gigantic displays in which everything is shown and but little seen. The facilities of communication for the transit of goods to Havre are much greater than at any previous French exhibition:—

Rules of the Exhibition.—Art. 1.—The Havre International Maritime Exhibition will be opened on the 1st of June and closed on the 31st of October, 1868. It will include an in-door and an out-door department.

Art. 2.—It is organized by the Society of the Havre Exhibition, under the patronage of H.I.M. the Emperor Napoleon, the Prince Imperial, the Havre Corporation, and a general consulting committee, of which the senateur-préfet of the Seine-Inférieur is honorary president; the committee is composed of the leading gentlemen interested in French commerce, navigation, art, science, &c.

Art. 3.—The demands for admission from intending British exhibitors must have been made.

Art. 4.—A moderate charge will be made to exhibitors, to cover the expenses of the building, arranging, insuring, &c. The rates are fixed as follows:—

In-door Department.—Closed Galleries.

Per superficial yard,		£1	0	0
Ditto	on the inside wall,	0	8	0

Space with Right of Selling Articles Exhibited.

Per yard frontage ($3\frac{1}{2}$ yards in depth),	£6	0	0

(This space is in the grand promenade of the building, and has its frontage towards the garden.)

Out-door Department.

Per superficial yard,	£0	4	0
With power of erecting roofs, sheds, &c.,	0	8	0

Pictures and works of art will be admitted without charge. Books, pamphlets, &c., will be charged 4s. per volume, the exhibition committee furnishing the necessary fittings for the library.

Art. 5.—Private spaces, glass cases, decorations and inscriptions, as well as buildings in the out-door department, must be erected by the exhibitors or their agents; but if desired, the exhibition contractors will undertake to erect them at the cost of the exhibitors.

Art. 6.—Stands and supports for articles weighing 2 cwt. or more will be provided at a reasonable charge.

Art. 7.—The distribution of space made by the directors of the exhibition will be announced at a later date.

Art. 8.—Articles intended for exhibition will be received in the buildings up to the 1st of May; after that date they cannot be admitted.

Art. 9.—An official catalogue will be published of the articles exhibited, indicating the spot they occupy in the buildings. This catalogue will include two alphabetical indexes—one of the exhibitors and one of the articles shown; extended explanatory notices of the exhibits can immediately follow the exhibitors' official class entry.

Art. 10.—Demands for reduced rates and facilities of transit have been addressed to all conveyance companies by land and water, and in most cases acceded to.

Art. 11.—The expense of transit of goods to and fro, packing or unpacking, must be borne by exhibitors.

Art. 12.—Foreign goods intended for the exhibition will be entered free of duty as "temporarily admitted."

Art. 13.—No article of any kind shown in the exhibition can be reproduced, copied, or drawn without the exhibitor's permission. The directors, however, reserve to themselves the right of permitting group drawings, photographs, &c., to be made.

Art. 14.—Exhibitors of machinery requiring water, gas, or steam-power, and those who intend having engines in motion, must give notice, when applying for space, of the speed and the motive power they will require. They will oblige by sending these particulars as soon as possible, in order that the committee may make the necessary arrangements for this special object.

Art. 15.—Every facility will be given to exhibitors for the sale of their goods; they will not, however, be allowed to remove them before the close of the exhibition. A special department is assigned to those exhibitors who wish to sell by retail.

Art. 16.—A free admission ticket, not transferable, will be delivered to every exhibitor, but it will be forfeited if lent or sold.

Art. 17.—Exhibitors have the right of entrusting their goods to their own agents, subject to the approval of the directors. Admission tickets will be delivered to these agents under the same restrictions as to exhibitors; but an agent will only have one ticket, however many exhibitors he may represent.

Art. 18.—During the exhibition juries will be chosen for each class of objects exhibited. Trials and experiments will be made, the results of which will be published in the *Monthly Gazette of the Exhibition*. The rewards given to exhibitors will consist of works of art, gold and silver medals, money prizes, and honourable mentions.

Art. 19.—Conference meetings and lectures will take place during the exhibition.

Art. 20.—The removal of goods at the close of the exhibition must be completed before the 1st of December; after that date goods, packages, and fittings not removed by exhibitors or their agents will be warehoused at the exhibitors' risk and expense. Objects not finally removed from the warehouse by the 30th of June, 1869, will be sold by auction, and the proceeds given to charities.

GROUP I.—NAVIGATION.

Class 1.—*Sailing Ships.*—Models and drawings of merchant vessels, pilot boats, yachts, and rowing boats; models and drawings of the ancient modes of navigation; Egyptian, Indian, Chinese, Japanese, Malay, and other vessels.

Class 2.—*Steam Vessels.*—Models and drawings of paddle and screw steamers for river, coasting, or sea voyages, transatlantic steamers of great speed, steam yachts, river steamers, towing steamers and steam barges, tugs, &c.

Class 3.—*Wooden Vessels, and Vessels constructed of Wood and Iron combined.*—Models and drawings of the hulls of wooden ships and ships of wood and iron combined; various improvements in the building of wooden vessels, planking and decking; stern fittings of screw steamers; specimens and models showing these improvements. Materials, tools, &c., used in ship yards for the construction of wooden ships; specimens of decks, bulk-heads, poops, sections of keels, stems, stern-posts, ribs, floor timbers, kelsons. Models of stoves for bending planks, knees, &c.

Class 4.—*Naval Constructions in Iron.*—Models and drawings of iron ships, screw colliers; various improvements in their build; models and plans of decks, and other parts of the fittings, tools, &c., employed in building-yards for iron ships.

Class 5.—*Boats.*—Canoes, launches or long-boats, cutters, dingies, galleys, whale boats, boats for raising anchors, &c.

Class 6.—*Masts.*—Models and drawings of wood and iron masts and yards; different modes of joining iron masts; telescopic masts; movable masts; specimens of wooden masts and yards, in the rough and finished state; specimens of iron masts.

Class 7.—*Rigging.*—Hemp rigging; iron wire; brass wire rigging; cordage of all sizes, running and standing, in Manilla hemp, flax, cotton, coir-yarn, &c.; cables, ropes, blocks and pulleys; sweeps, oars, tholes, &c.

Class 8.—*Sails.*—Linen, cotton, and incombustible sails; sewing machines for making sails; models and drawings of sails; systems of reefing top-sails, brails and clue-lines.

Class 9.—*Ship Fittings.*—Anchors, chains, capstans, windlasses, and hawse-holes; apparatus for dropping and raising anchors; links, grapnels; pumps of various kinds; rudders of all kinds; steering wheels; fittings in galvanized iron; companion ladders; powder magazines. Distilling apparatus; bread-rooms, kitcheners, galleys, cooking-stoves, furnaces, and other heating apparatus; pitch, tar, rosin.

Class 10.—*Preservation of Naval Constructions.*—Paint, coatings, compositions, and cements for preventing the fouling of ships' bottoms; zinc and copper sheets: application of electro-chemicals for the preservation of iron ships; ventilation of the hold, &c.; rendering wood incombustible; various fittings for careening, fastening, and caulking ships.

Class 11.—*Furniture of Ships, Steamers, and Yachts.*—Cabin fittings, wash-stands, baths, and various fittings for the comfort of passengers; tables, stools, folding chairs, and various seats; beds and bedding, swing cots, hammocks. Scuttles and skylights; hanging and swinging lamps. Carpets, oilcloth; looking-glasses, mirrors, gilt frames; heating stoves; glass; china; linen. Table service for ships, steamers, and yachts; pantry and stewards' fittings; water-closets; utensils, and special fittings for emigrants.

Class 12.—*Ships' Stores.*—Preserved provisions of all kinds; biscuits; refrigerators and icing apparatus; filters, casks, and tanks for preserving fresh water; demijohns; models of store-rooms; drinks and liquids; preserved meats of all kinds—salted, dried, cured, smoked, spiced, or preserved in gelatine; preserved eggs; fish—pickled, salted, or smoked by any process; preserved potatoes and other vegetables; fruits, dry or preserved; bread and biscuit baking ovens.

Class 13.—*Sailors' Outfit.*—Ready-made clothes for sailors; tarpaulings, oil-skins, and waterproof clothing; furs and skins; sou'westers; waterproof boots; trunks, and outfits for sea voyage.

Class 14.—*Instruments of Navigation, Steering Apparatus, Lighthouses, and Signals.*—Chronometers, compasses, charts, barometers, thermometers, sextants, quadrants, astronomical instruments, telescopes, automatic and electric plummets, and sounding lines; sand-glasses, compass cards, hygrometers; lightning conductors, &c. Lighthouses, beacons, signals, flags, lanterns, bell buoys; telegraphs for lighthouses, semaphores, watch-houses; blue-lights and other coloured lights, revolving lights, electric lights, whistles, fog bells, electric bells, engine bells; shells and rockets for signals, signal guns, telegraphic indicators of the position of the rudder; various buoys; electric buoys communicating with semaphore station.

Class 15.—*Hygiene, Pharmacy, and Surgery on Shipboard.*—Marine hygiene, medicine chests, drugs and chemicals; preservation against, and treatment of, sea sickness; anti-scorbutics; splints and mechanical apparatus for fracture of limbs at sea, surgical appliances and instruments. Modes of cleaning, ventilating fumigating, and disinfecting ships. Preparations and apparatus for destroying rats, cockroaches, bugs, and other vermin.

Class 16.—*Loading, Stowing, Landing, Transporting Apparatus.*—Tents and shelters; ships' shears, windlasses, movable and permanent cranes, screw presses, steam cranes, &c.

Class 17.—*Salvage Apparatus, Lifeboats, &c.; Swimming and Bathing Apparatus.*—Models and drawings of lifeboats; salvage clothes, waterproof cloths, life belts, cork jackets, air cushions, nautilus, diving bells, submarine boats, waterproof boats, submarine lights, life buoys, carriages for lifeboats; rafts, cork mattresses, &c. Signal guns and rockets. Swimming apparatus, swimming belts and bathing costumes, &c.; models and drawings of swimming baths.

Class 18.—*Paddle Propellers.*—Models and drawings of fixed and jointed paddle wheels; feathering apparatus, various improvements.

Class 19.—*Propellers.*—Models and drawings of screw propellers with curved or straight blades; fixed screws; other descriptions of propellers.

Class 20.—*Motive Powers of all kinds.*—Models and drawings of steam-engines worked by ether, compressed air, combined steam and air, gas, and electric motors.

Class 21.—*Boilers and Generators; Steam Fuel.*—Models and plans of medium, low, and high-pressure boilers, smoke-consuming apparatus, furnaces. vent holes, fire-grates, safety valves, water levels, &c.; coals, coke, compressed fuel, &c. Coal bunks, coal shipping and landing apparatus.

Class 22.—*Various parts of Marine Engines and Accessories.*—Condensors; air pumps; taps and apparatus of injection; valves, &c., employed with condensors, &c.

Class 23.—*Ports and Harbour Works; Ships' Repairs.*—Models, drawings, and plans of ports, harbours, piers, jetties, breakwaters, docks, wharfs, dredging machines, various drags; bridges, steam-passenger bridges, dock gates; pontoons, various apparatus for cleansing and repairing ships' bottoms.

GROUP II.—MERCHANDISE AND TRADE PRODUCTS.

Class 24.—*Textile Materials, Cotton, Hemp, Flax, Jute, Wool, Hair, &c.*—Samples of these goods in their raw state, and their economic applications; cotton seed and its uses.

Class 25.—*General Produce Home and Foreign.*—Raw and refined cane sugar and molasses, syrups, cocoas, coffees, teas, vanilla, cloves, cinnamon, ginger, nutmeg, pepper, tobacco leaf, india-rubber, gutta-percha, wax, coca leaf; lime juice. Beetroot sugar and molasses, native wax, and home-grown tobacco.

Medicinal Drugs as imported.—Rhubarb, sarsaparilla, ipecacuanha, cinchona, cinnamon and other barks; senna leaves, tamarinds, &c.; gums and resins from all sources; camphor, opium, &c.

Class 26.—*Cereals, Flours, Fruits, and Seeds.*—Wheat, rye, oats, maize, barley, buckwheat, rice, potatoes, dhurra, lentils, beans and peas of all kinds; chestnuts, oranges and lemons, almonds, olives, capers, raisins, ground nuts, dates, figs; anise and other aromatic seeds; clover, castor oil seed; gingelly or sesame, colza, linseed, mustard, rape, and other oil seeds; juniper berries.

Class 27.—*Dye Stuffs, Tanning Substances and Chemical Products.*—Cochineal, kermes and lac; logwood, Brazil wood, Pernambuco wood, bar and camwood, fustic, yellow dyewoods of Cuba, sandalwood, sappan wood, indigo, madder root, garancine, turmeric, quercitron, sumach, orchella and other dye lichens; saffron, safflower, arnotto, valonia, gall nuts, cutch; liquid or solid dye extracts from vegetable or mineral substances; tanning barks; chromates, prussiates, &c.

Class 28.—*Oils and Fats.*—Fats of all kinds; ground nut, olive, colza, cocoa-nut, palm oil, castor oil, and other oils; essential oils of orange, cloves, cinnamon, peppermint, citronella, &c.; whale, sperm, seal, cod-liver, sardine, shark, and other fish oils; shale, petroleum, and other mineral oils; neatsfoot oil, trotter oil, bone oil, mares' grease, tallow, dugong, and other animal oils.

Class 29.—*Woods for Building, Cabinet Making, &c.*—Woods for shipbuilding and maritime constructions; rough and prepared specimens of squared, sawn, and shaped woods; furniture and ornamental woods for cabins of ships, tables, marquetry; mahogany, walnut, rosewood, maple, ebony, lignum vitæ, cedar, orange, oak, &c.; scented woods for perfumery; trunks and stems, &c., for working into various purposes, as sticks, cocoa-nut husks for coir, rushes and reeds, bamboo, rattans, esparto, &c.

Class 30.—*Metals of all descriptions and Metallic Salts.*—Copper, lead, iron and steel, gold and silver, zinc, cinnabar and mercury, tin, and minerals of all kinds; salts and metalloids; borax, arsenic, &c.

Class 31.—*Raw Materials and Manufactured Articles—1st Division—Animal Products.*—Hides and skins, bones, whalebone, horns, ivory, tortoise shell, mother-of-pearl, and other shells.

2nd Division—Food Products.—Maccaroni and vermicelli; biscuits, gingerbread, and other products of the baker and confectioner capable of being preserved on sea voyages; preserved meats, fish, eggs, vegetables and fruits; condensed milk, cheese, meat-biscuits, extracts of meat, hams, bacon, tongues, tripe, and other preparations of animal food; condiments and stimulants, as teas, coffees, chocolates, bitters and aromatic drinks; sugars, and confectionery; spirituous and fermented drinks, wines, alcohols, liqueurs, and cordials.

Clothing and Accessories.—Threads and fabrics of cotton, flax, hemp, and other textiles; wool and silk; shawls and wrappers; lace, embroidery and trimming; needles; hats and hosiery; garments for both sexes; furs; jewellery and ornaments; perfumery and hair-dressing appliances; objects of necessity for daily use in leather; basket work, toys, &c.

Furniture and Decorations.—Carpets, floor-cloths, paper-hangings, glass, china, earthenware and cutlery; window glass, apparatus and processes of heating and lighting; clocks and watches, bronzes, and other ornaments cast or wrought in metal.

Materials, &c., for the Construction of Dwellings.—Models, sketches, and plans; iron stores and dwellings especially adapted for colonies and foreign countries; collections of specimens of building stones, minerals and metals, marbles, earths and clays; applications of these, as works in marble, tinware, edge tools, hardware, and iron founding, coppersmith's work, iron-plate manufacture, locksmith's work, iron safes, &c.

Machines.—Materials and implements for machinery in general; machines, tools, and processes for various works, industries, and modes of locomotion by land; carriage-making and wheelwrights' work; saddlery and harness.

Liberal Arts.—Printing, stationery, and bookbinding; materials for drawing and painting; proofs and apparatus for photographing: maps, charts, globes, and all that relates to geography; scientific instruments; musical instruments. Objects of voyage and encampment, portable arms for the person and cheaper kinds for exportation.

Class 32.—*Instruments and Apparatus used in commerce to determine the Quantity, Quality, or Adulteration of Goods.*—Weighbridges, steelyards and balances, beams, scales, oil testers, saccharometers, alcohometers, probes and tasters, &c.

Class 33—*Packing.*—All kinds of articles used for packing and baling the various descriptions of merchandise transported by international maritime commerce to different destinations; boxes, packing cases, sacks, barrels, carboys, trunks, chests; substances used to protect packages and goods, as waterproof paper, oiled canvas, incombustible cloth, zinc, tinned iron, various woods, mattings, baling, skins, &c.

GROUP III.—FISHERIES.

Class 34.—*Whale and Sperm Fishing.*—Models and drawings of ships, boats, and their fittings, &c., for the whale and seal fisheries; apparatus and modes of fishing.

Class 35.—*Cod Fishing.*—Models of vessels, boats, hooks and lines, and all the appliances for cod fishing.

Class 36.—*Coast Fishing.*—Deep-sea nets, floating or drag nets, oyster dredges. Models of fishing boats for these purposes. Making and preservation of the nets. Floating nets, cast nets, and seines for mackerel, herring, pilchard, sardines, &c. Fixed nets and fisheries, various proceedings connected therewith.

Class 37.—*River and Pond Fishing.*—Angler's outfit for river and pond fishing; fishing rods, baskets; models and drawings of boats, punts, &c.

Class 38.—*Specialities for Fishing.*—Various baits; artificial flies; modes of fishing and salting on board—preparation for different markets; salt, casks, &c.; preparing fish on shore; models of works for drying, smoking, pickling, salting, &c.; various fittings, utensils, clothes, &c., for different fisheries, as the whale, seal, cod, &c.

GROUP IV.—FISH CULTURE.

Class 39.—*Fresh and Salt Water.*—Improvements in the breeding and preservation of oysters, mussels, salmon, &c.; various systems of elevating; models of establishments for the spawning of fish and crustacea.

GROUP V.—SUPPLEMENTARY CLASSES.

Class 40.—*Fine Arts Annexe.*—Carved statues and figure-heads for ships, attributes and ornaments; decorative pictures for cabins, &c.; models of rigged ships, in wood, ivory, metal, glass, &c. Marine paintings, sketches, water-colour drawings, designs, engravings, lithographs, marine photographs, &c.

Class 41.—*Books on Maritime, Fishing, or kindred subjects.*—Published works of all kinds on marine engineering, navigation, shipbuilding, gunnery, meteorology, fishing.

Class 42.—*Experiments and Contests.*—A comparison will be made between the French and foreign ships that may enter the port of Havre up to the 31st October, 1868, whether steamers or sailing vessels, fishing smacks and boats, tugs, pilot boats, transports, or other descriptions of vessels. These ships will be visited on arrival by a special commission, which will inspect the build of the ship, her condition on entering port, as regards hull, rigging, sails, &c. The chief points to be taken into consideration will be the rapidity of passage, log, health, comfort, and food of the crew, passengers, and emigrants, and general arrangements of the ship. Prizes will be awarded to the most deserving shipowners, captains, mates, and seamen.

Class 43.—*Fêtes.—Special Experiments on the water.*—Regattas and maritime fêtes, sham fights, and spectacles by night and by day will take place. Contests between the engineers, and between the working men of various marine establishments, will also take place.

Railway Communication.—Mr. Steven Holness, of Southgate Road, London, has patented an arrangement for effecting oral intercommunication between passenger, guard, and driver of a railway train. He proposes to place beneath the flooring of each carriage a metal speaking tube, connected between the carriages by a continuation of coupled india rubber tubing, forming a line of communication between the guard and driver at either end of the train; the pipe to be supplied at each end with an alarm whistle. He also furnishes each compartment of the carriages with an intercommunicator, which will enable the passengers to communicate with the guard or driver through the same pipe. Across the mouthpiece in each carriage there is placed a small clasp, secured by a seal (that must be broken before the apparatus can be used), which, by acting as a detector, is a security against improper use. In order to communicate, it is simply necessary to break the seal, pull out the pipe as far as it will come, and hold it so till the communication is complete, informing the guard of the number of the carriage, after which the pipe is allowed to return to its place by the action of a spring. The inventor urges that, at a small cost, a most simple and comprehensive system of oral communication from all parts of a train may be obtained, whilst the manner of using it is so obvious as to afford no possible obstacle to its being called into requisition when needed.

Military Telegrams.—Some important experiments in sending military telegrams will take place this year, for the first time, at the camp at Chalons. With that view several clerks acquainted with the mode of proceeding, and probably selected from amongst those who had formerly been in the army, will be detached and placed under the orders of officers of the staff.

Natural Aniline.—Mons. Ziegler, of Muhlhouse, has subjected to a careful examination the red colouring matter which is secreted by a mollusc (*Aplysia depilans*), generally known as the sea hare, which animal is not rarely found on certain coasts, and is especially abundant on the coast of Portugal after heavy storms. The colouring matter has a peculiar odour, and serves the animal as a defence against its enemies by rendering the water turbid and at the same time disagreeably odoriferous. A chemical examination disclosed the fact that the colouring matter is analine with a slight admixture of other organic substances, and that it can be easily obtained in a state of purity; but as the pound would cost about 60 francs this new source of aniline is practically without any value. The most interesting part of the article is the plausible suggestion of Mons. Ziegler that the sea hare and not the murex, as now generally believed, is the animal from which the Phœnicians obtained their famous purple, and thus it is rendered probable that the priceless purple of Tyre, the only dye thought fit for the imperial vestments of ancient Rome, is identical with the cheap coal-tar aniline of modern manufacture.

Manufacture of Salt.—A company has lately been formed at the salt lakes near Cressy, to manufacture salt by natural evaporation. These lakes are about 45 miles from Geelong, and are about 30 miles from Leighroad station of the Melbourne and Ballarat Railway. Large quantities of salt have years ago been brought into Geelong and Melbourne from the lakes, and went into general consumption, and the trade gradually progressed from 1844 to 1850, when the gold fields caused its total abandonment. Some years ago, about 80 tons were collected for the Ballarat market, since when other annual deposits have been collected and disposed of at Geelong and Ballarat.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

21st April, 1868.

1290 J. Woolfield, Handsworth—Corrugating sheets of metal
1291 A. Cole, Erith, and J. Carter, Bexley Heath—Lamps
1292 S. Jackson, Bury—Propelling motive power
1293 W. Gorse, Birmingham—Strips of iron and steel
1294 E. Kemp and H. Gourlay, Dundee—Marine steam engines
1295 A. Paget, Loughborough—Pulling of ropes
1296 G. Coles, Gresham Street, West, J. A. Jacques and J. A. Fanshawe, Tottenham—Producing thin strips
1297 L. Bing, Bishop's Stortford—Ascertaining the actinic power of light
1298 S. Dreyfous, Paris—Removing cotton from cotton pods.—A com.
1299 A. D. Renshaw, Fetter Lane—Clipping the wool or hair of animals
1300 J. H. Johnson, Lincoln's Inn Fields—Correcting the deviations of the mariner's compass in iron ships.—A com.
1301 J. & H. T. Tugl, Clerkeuwell—Curtain poles

22nd April, 1868.

1302 M. S. Maynard and R. Grime, Preston — Governing the speed of motive-power engines
1303 J. Johnson, Levensbulme—Metallic packings for pistons
1304 J. Edwards, Hackney—Railway point indicators
1305 W. Clarke, Nottingham—Ornamental fabrics in twist lace machinery
1306 J. Holyroyd Bolton, Manchester—Sizeing and drying warps
1307 C. B. Ingham, Manchester—Stamping marks or designs
1308 T. Whittaker, Manchester—Liquid proof fabrics
1309 H. House, Lime Street—Safety matches
1310 R. Side, Southwark—Motive-power machines
1311 A. Fiddes and C. J. Curtis, Bristol—Safes
1312 T. L. Scowen, South Hornsey—Hook button for boots
1313 T. L. Scowen, South Hornsey—Button boot without button holes
1314 W. R. Lake, Chancery Lane—Lubricating packing.—A com.
1315 W. R. Lake, Chancery Lane—Small articles from sheet metal.—A com.
1316 W. R. Lake, Chancery Lane—Carpet linings.—A com.
1317 H. Hill, Nottingham—Water-closets
1318 W. E. Newton, Chancery Lane—Paddle wheels.—A com.
1319 H. D. Cbard, Feniton—Buildings
1320 H. H. Murdocb, Staple Inn—Concaves
1321 R. F. Fairlie, Gracechurcb Street—Railway carriages
1322 D. Skeoch, Stewarton—Spindles used for spinning or twisting yarns
1323 E. Samson, Bethnal Green—Tables

23rd April, 1868.

1324 W. Hamilton, Glasgow—Generating steam
1325 T. Hardcastle, Bolton—Bowls for mangles
1326 E. Rostron and W. W. Whittaker, Manchester—Felt
1327 J. Whitehouse, Tipton—Tailors' irons
1328 J. Bush and H. Welcbman, Aston-juxta, Birmingham — Spring fastening for brooches
1329 J. M. Stanton, Philadelphia—Furniture castors
1330 G. F. & J. Stidolph and T. Simpson, Woodbridge—Brushing machines
1331 A. M. Clark, Chancery Lane—Multiplying motive power
1332 J. Armstrong, Masbro'—Permanent way of railways
1333 W. R. Lake, Chancery Lane—Steam cultivator.—A com.
1334 C. B. & J. Hardich, Brooklyn—Direct-acting engines
1335 J. Reid, Glasgow—Casks
1336 J. Rogers, Islington—Utilizing certain vegetable products
1337 J. Casson, Sbeffield—Sawing wood
1338 A Carter, Birmingham—Nails
1339 W. R. Lake, Chancery Lane—Cartridge boxes.—A com.

24th April, 1868.

1340 M. Z. D. Aschau, Oxford Street—Sambucoid
1341 J. Baggs, High Holborn—White lead
1342 T. T. Macneill, Charing Cross—Indicating the distances travelled by cabs
1343 C. Brown, Dublin—Baking
1344 J. R. Johnson, Red Lion Square—Repeating fire-arms
1345 R. & T. Nuttall, Walmsley, and B. Barber, Manchester—Woven fabrics
1346 D. C. Lowber, Chancery Lane—Wire tie for securing bales
1347 C. W. Harrison, Clapham Junction—Preventing incrustation in boilers
1348 J. Liddard and G. Buxton, Birkenbead—Railways
1349 J. Wetberhilt, Mayfair—Scoring at billiards
1350 W. H. Ryland, Birmingham—Fastenings for articles of dress
1351 J. Dewar, Kirkcaldy—Preserving manure
1352 W. Bartram, Sheffield—Cartridges
1353 W. Bartram, Sbeffield—Filling and recaping cartridges
1354 G. A. Welch, Sydenham—Preserving life and property at sea
1355 J. Bernard, Strand—Preparing and dressing ores

25th April, 1868.

1356 T. F. Cashin, Sheffield—Regulating the working of railway signals
1357 W. N. Hutchinson, Wellesbourne—Checking the recoil of ordnance
1358 G. Marson, Eagley—Retaining the outer ends of tapes
1359 J. Craven, Tbornton—Barrel fringe
1360 J. & R. Holding, Wheelton—Looms for weaving
1361 P. Spence, Newton Heath—Purifying gas used for illuminating
1362 A. W. Pocock, Pimlico—Working valves of steam engines
1363 R. Cocker, Westminster—Preserving wood——A com.
1364 C. Drake, Kennington—Constructing concrete buildings
1365 A. Clark, Chancery Lane—Steam generators.—A com.
1366 A. Parkes, Birmingham—Varnishes
1367 J. Atkins, Birmingham—Ornamenting sheets of metal
1368 T. Pemberton and T. Hughes, Birmingham—Supports for fire-irons
1369 F. C. Hills, Deptford—Gas

27th April, 1868.

1370 E. P. H. Vaughan, Chancery Lane—Communicating signals.—A com.
1371 J. Hepworth and G. W. Bayldon, Wakefield—Boilers
1372 S. Tidmarsb, Birmingham—Locks
1373 D. Geraci, Florence—Armour-plating material
1374 V. Delperdange, Brussels—Connecting pipes
1375 P. Nisser, Minories—Safety blasting powder
1376 K. V. Barnekov, Newburgh—Breechloading fire-arms
1377 H. Chaytor, Witton Castle—Rolling stock of railways
1378 R. Holt, R. Burlison, and H. Sampson, Bradford—Finishing woven fabrics
1379 L. Perkins, Gray's Inn Road—Wrought metal wheels
1380 J. Scoffern, Finsbury—Sheathing ships' bottoms
1381 L. Perkins, Gray's Inn Road—Tubular steam boilers

28th April, 1868.

1382 E. M'Donnell, Fareham—An impervious concrete or cement
1383 J. & M. Pearson, Thornton—Jacquard engines
1384 G. T. Bousfield, Brixton—Hair seating
1385 G. A. Cox, Lochee—Carpets and other similar textile fabrics
1386 A. Jack, Maybole—Reaping machines
1387 A. Baal and C. Gann, Jersey—Reefing fore and aft sails
1388 A. Dietz, New York—Refining glue
1389 H. Waugh, Whitefriars—Separating grain
1390 W. Whitworth, Leeds—Sewing machines
1391 E. A. Rippingille, Holborn Hill—Obtaining motive power
1392 J. Bottomley, Laister Dyke—Umbrellas

29th April, 1868.

1393 G. B. Babacci, Florence—Gas engines
1394 S. Robotham, Birmingham—Bird cages
1395 J. Gray, Glasgow—Coverings for preventing the fouling to which ships are liable in sea water
1396 T. & G. Cope, Liverpool—Moulding and stamping tobacco
1397 W. Wright, Mostyn—Iron and steel
1398 A. Geary, Bristol—Protecting the moustache when eating soup
1399 C. D. Fox, Spring Gardens—Nicking and dressing the heads of screw blanks
1400 J. Booth, Nottingham—Fabrics in twist lace machines
1401 J. J. Long, Glasgow—Matches
1402 J. M'Kean, Walmer Bridge, and J. Stenhouse, Pentonville—Sizeing or dressing yarns
1403 H. Deacon, Appleton—Chlorine
1404 R. Scott, Edinburgh—Dressing millstones
1405 J. H. Johnson, Lincoln's Inn Fields—Preserving meat.—A com.
1406 R. Heathfield, Birmingham—Cut nails.—A com.
1407 A. Homfray, Halesowen—Iron or steel shackles

30th April, 1868.

1408 F. Wise and E. Field, Westminster—Effecting the removal of foreign matters from water
1409 J. Gough, Hatton Garden—Gearing for actuating the knife in paper-cutting machines
1410 W. Ferrie, Monkland Iron and Steel Works—Blast furnaces
1411 J. Dendry and J. R. Beard, Manchester—Woven fabrics
1412 J. Bettcley, Bootle—Shipbuilding fastenings
1413 R. Ward, Newcastle-upon-Tyne—Twisting tobaccco
1414 J. H. Cassell, Limehouse—Sheathing iron ships
1415 S. Chatwood, Bolton—Safes
1416 S. Parr and A. Strong, Cannon Street—Combining certain materials in the roofs and floors of houses
1417 J. W. Goundry, Old Sheldon—Carrying railway and other tickets
1418 B. F. Weatherdon—Chancery Lane—Soldering tin boxes
1419 M. A. F. Mennons, Paris—Planing.—A com.
1420 W. R. Lake, Chancery Lane—Spinning fibrous materials —A com.
1421 T. Beeley, Hyde Junction Iron Works—Boilers
1422 J. H. Johnson, Lincoln's Inn Fields—Gelatine.—A com.

1st May, 1868.

1423 J. Lillie, Manchester—Measuring the flow of liquids
1424 C. D. Abel, Chancery Lane—Colouring matter from aniline
1425 E. Leheup, Bethnal Green—Wooden boxes
1426 A. Munro, Arbroath—Tool holders for cutting stone
1427 A. B. Childs, Mark Lane—Separating mixed substances
1428 J. Warne, Blackfriars' Road—Fastening for pipes
1429 W. E. Everitt, Birmingham—Copper and metal tubes
1430 P. Martin and A. Tack, Brussels—Producing gases from liquid hydrocarbons
1431 J. H. Johnson, Lincoln's Inn Fields—Shearing textile fabrics—A com.

2nd May, 1868.

1432 J. Heaton, Langley Mill—Reverberatory furnaces
1433 F. Barnett, Paris—Unspillable pale
1434 H. A. Bonneville, Paris—Measuring the flow of liquids.—A com.
1435 H. A. Bonneville, Paris—Propelling vessels.—A com.
1436 T. Hawes, F. W. & G. Spencer, and J. Stenner, Tiverton—Seed and manure drill
1437 E. G. Camp, Bristol—Mallets
1438 L. Binns, Brighouse—Looms for weaving
1439 H. Y. D. Scott, Ealing—Kilns for burning lime
1440 J. Maistre, Ville-neuvette—Dyeing wool
1441 A. Smith, Stratford—Furnaces for burning creosote
1442 J. E. Boyce and R. Harrington, Birmingham—Umbrellas
1443 J. H. Johnson, Lincoln's Inn Fields—Exhibiting photographic pictures.—A com.
1444 W. R. Lake, Chancery Lane—Generating gas.—A com.
1445 J. L. Budden, Fenchurch Street—Dyeing wool
1446 W. R. Lake, Chancery Lane—Buckets.—A com.
1447 W. R. Lake, Chancery Lane—Dynamometers.—A com.

4th May, 1868.

1448 H. Glover, Bermondsey—Retaining corks
1449 W. E. Gedge, Strand—Applying a coating of silver to animal and vegetable substances.—A com.
1450 A. Vickers, Bayswater—Locking the nuts of screw bolts
1451 J. Mathie, Anvers—Warehousing petroleum
1452 C. P. Aston, Chelsea—Chimney tops
1453 J. Wertheim and L. Hirschhorn, Hatton Garden—Lockets.—A com.
1454 T. & G. A. Pemberton, Birmingham—Alarm bells
1455 E. & G. H. Morgan, Edgware Road—Carriages
1456 W. Marshall, Old Basford—Clipping of lace
1457 W. Eastor, Hampstead, and M. Terrero, Belsize Park Gardens—Preserving animal substances

5th May, 1868.

1458 D. P. Wright, Birmingham—Measuring the flow of liquids
1459 D. P. Wright, Birmingham—Taps
1460 W. Taylor, Poplar—Iron and steel ships
1461 W. Sketchley, Weymouth—Wood cutting
1462 C. W. Siemens—Westminster—Cast steel
1463 C. D. Abel, Chancery Lane—Axle boxes for the rolling stock of railways
1464 F. W. Gerhard, Wolverhampton—Motive-power engines
1465 J. Dawber, Over Darwen—Steam engines
1466 J. Clough, Keighley—Screw-gill boxes
1467 J. Hickmott, Clapham—Preserving metallic articles from decay
1468 J. Court, Sheerness—Traps for receiving sewage matters
1469 G. Kent, High Holborn—Ice preservers
1470 D. R. Macgregor, and P. Taysen, Leith—Paint for the protection of iron.—A com.
1471 W. Beale, Taunton—Ladders
1472 W. Walker and H. F. Smith, Hull—Expressing oils
1473 F. J. King, Leadenhall Street—Preparing potatoes for preservation
1474 J. Lamb and S. Tovey, Kidderminster—Bobbin frames
1475 W. E. Newton, Chancery Lane—Forming picking axes
1476 J. Wilkinson, Hunslet—Printing carpets

6th May, 1868.

1477 A. Scott, Paddington—Attaching clothes to the person
1478 J. M. Stanley, Rhyl—Heating apparatus
1479 R. Lubliuski, City Road—Fasteners for the tips of umbrellas
1480 T. Warren, Glasgow—Glass furnaces
1481 J. Young, Aspull—Ovens
1482 C. J. Chubb, Hampstead—Getting coal
1483 J. & J. B. Palmer, Bow—Friction matches
1484 H. J. Davies, Dalton-in-Furness—Compositions for cleaning gold
1485 A. C. Henderson, Charing Cross—Albumen.—A com.
1486 S. Drummond, Ardwich, J. Clare, Greenfield, and R. Hughes, Didsbury—Preventing fraud in the collection of fares in omnibuses
1487 F. T. Hall, Gray's Inn Square—Railway and other tickets.—A com.
1488 W. E. Newton, Chancery Lane—Combs.—A com.
1489 M. Henry, Fleet Street—Steel and iron
1490 S. Holt and J. Kearsley, Manchester—Observations on railways for preventing accidents
1491 J. G. Walker, Bonnington, and C. Stein, Leith—Separating tares from grain.—A com.
1492 J. G. Walker, Bonnington—Dressing millstones
1493 W. Harvie, Glasgow—Lamps and lanterns
1494 J. H. Johnson, Lincoln's Inn Fields—Increasing the draught in steam-boiler furnaces.—A com.

7th May, 1868.

1495 M. A. Muir and J. M'Ilwham, Glasgow—Power looms
1496 H. A. Bonneville, Paris—Spring mattresses.—A com.
1497 B. Pickering, Hull—Expressing oils
1498 R. A. Green, Strand—Bearings
1499 A. C. Henderson, Charing Cross—Plates for heliographic engraving.—A com.
1500 A. C. Henderson, Charing Cross—Renovating files.—A com.
1501 K. H. Cornish, South Molton Street—Entrenching tools
1502 R. Harlow, Heaton Norris—Supplying water to baths
1503 A. Strauss, Basinghall Street—Pipes for smoking
1504 J. H. Johnson, Lincoln's Inn Fields—Sewing machines.—A com.
1505 W. E. Gedge, Strand—Portable apparatus.—A com.
1506 W. E. Gedge, Strand—Throstle frames for spinning flax.—A com.
1507 R. Evans, and J. Bruce, Birmingham—Dressing millstones
1508 J. Bruce and R. Evans, Birmingham—Bolters for dressing flour

8th May, 1868.

1509 R. K. Miller and A. B. Herbert, Edinburgh, and H. Watson, Newcastle-on-Tyne—Knotters for straining paper pulp
1510 G. Bowden and J. R. Dickinson, Oxford Street—A new fluted brush
1511 H. N. Penrice, Norwich—Forming tunnels
1512 W. Husband, Hayle, and F. B. Doering, Westminster—Holding the stands of excavating machines
1513 C. E. Brooman, Fleet Street—Preparing zirconia.—A com.
1514 A. James, Redditch—Polishing needles
1515 W. Leck, Bockenheim—Hulling and winnowing grain
1516 J. A. Jones, Middlesborough—Iron and steel

9th May, 1868.

1517 G. F. Griffin, Westminster—Corking bottles
1518 J. C. Bowler, Bowden—Castors
1519 J. Norman, Glasgow—Calcining ores
1520 W. E. Everitt, Birmingham—Casting copper tubes
1521 H. H. Hazard and W. Grimwood, New Cross Road—Revolving shutters
1522 S. Moulton, Bradford—Treatment of vulcanized india-rubber
1523 R. Waygood, Newington—Stoves
1524 A. M. Clark, Chancery Lane—Breech-loading fire-arms.—A com.
1525 W. H. Wilkinson, Chancery Lane—Combining types
1526 J. H. Crane, Royal Exchange—Breech-loading fire-arms.—A com.
1527 G. T. Seydel, Tavistock Square—Heating and ventilating buildings
1528 S. Hall, Swansea—Artificial fuel
1529 J. H. W. Biggs, Manchester—Selecting warp threads

11th May, 1868.

1530 R. Moore, Glasgow—Treatment of crushed sugar
1531 J. Crossley, Heckmondwike—Looms for weaving
1532 W. Webster and R. W. Barnes, Southport—Head and waist rests
1533 A. D. E. Boucher, Fumay—Moulding hollow metallic pieces
1534 A. D. E. Boucher, Fumay—Applying enamelled cast iron for superseding china and crystals
1535 A. M. Dix, Shelton—Supplying finings to casks
1536 C. E. Brooman, Fleet Street—Furnaces.—A com.
1537 W. R. Lake, Chancery Lane—Device for holding scrubbing brushes.—A com.
1538 J. B. Kingham, Dorchester—Nail machines
1539 A. Holbrook, Lynn—Sewing books
1540 R. Leake and J. Beevers, Barnsley—Preventing smoke in steam-boiler furnaces

12th May, 1868.

1541 S. Buxton, Kingsland—Writing and printing pens
1542 T. Briggs, Manchester—Metal bands for securing bales
1543 G. A. H. Dean, Ludgate Hill—Envelopes.—A com.
1544 W. R. Lake, Chancery Lane—Fans.—A com.
1545 T. Pope, Twickenham—Currycomb
1546 S. F. Armstead, Islington—Blow-pipe apparatus
1547 C. Vero, Atherstone—Hats
1548 T. Shinton, Blaina—Forming the ends and joints of pipes
1549 W. D. Brown, Mains of Turin—Reaping and mowing machines
1550 J. H. Nutt, Kingston-upon-Hull—Straining surface for oil

13th May, 1868.

1551 J. Slater, Lansdowne Road—Breaking up macadamized roads
1552 S. B. Boulton, King William Street—Conveying timber in timber yards
1553 F. W. & W. J. Crossley, Manchester—Breaking the boon of flax
1554 H. B. Barlow, Manchester—Preventing incrustation in steam boilers.—A com.
1555 G. Dixon, Cannonbury—Upholsterers' fringes
1556 A. & A. C. M. Prince, Charing Cross—Telegraphic communication by pneumatic means
1557 S. B. Allen, Boston—Rasps.—A com.
1558 C. Farrow, Great Tower Street—Cleansing bottles
1559 J. W. Chamberlain, Massachusetts—Steam engines.—A com.
1560 M. Lefi, Old Broad Street—Marine boilers
1561 W. Taylor, Poplar—Iron and steel ships
1562 W. Baldwin, Blackburn—Looms for weaving
1563 H. B. & A. Mullord, Hoxton—Ornamenting bonnets
1564 C. Iles, Balsall Heath—Ornamenting thimbles
1565 R. M. Clune and F. W. Davies, Worcester—Harrows
1566 W. E. Newton, Chancery Lane—Braces.—A com.
1567 F. Dixon, Clipstone Street—Packing cases for holding bottles
1568 W. E. Newton, Chancery Lane—Axles and axle boxes.—A com.
1569 W. Tasker, Andover—Steam engines

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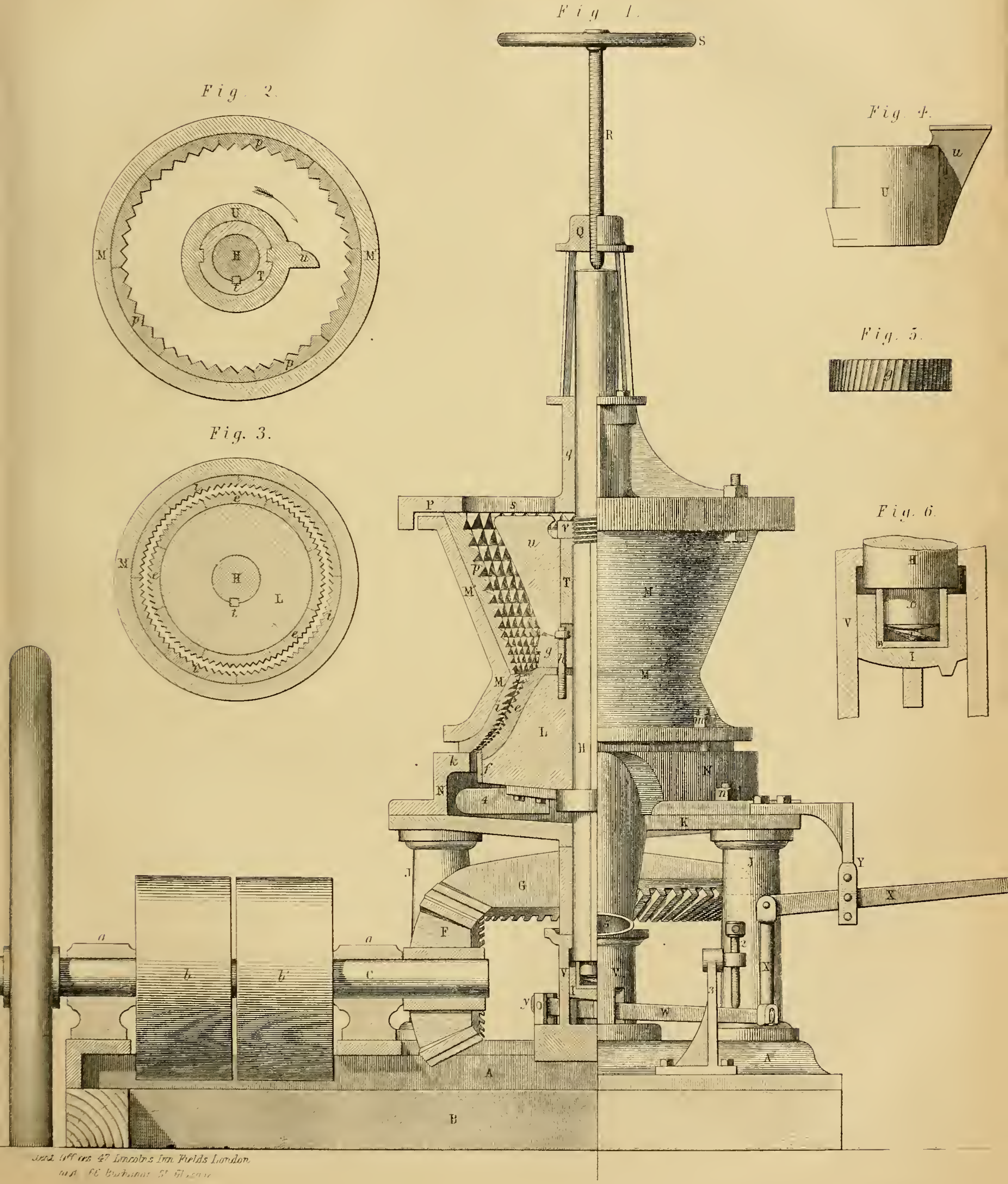

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ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXIX.

MALLEABLE CASTINGS.

AMONGST the array of surprising facts presented in such numbers in the chemistry of the metals, none probably match in strangeness, interest, and technical importance, those which appertain to iron in its various conditions as employed in industry. The conversion of those innumerable compounds all classed under the common title of cast or pig iron into wrought or malleable irons, with a range of physical qualities almost as diverse and remarkable as those of the parent crude material; the conversion of certain pig irons, and certain only, into steel direct, by slight changes in the same process by which wrought iron is procured by puddling; the production of like final results by the Bessemer process; the power of procuring from the same crude iron, steel that shall be soft enough to draw out to the extent of one-sixth of its length before fracture, or other that shall be so rigid as not to admit of much more extension than a piece of glass, and yet have a tension coefficient of thrice the preceding; the great range and variety of properties that may be given to steel of cementation even from the same bar iron; the power to make cementation steel at all, from only certain wrought irons; the capacity of the same piece of steel, by mere variation in the rate at which it has been heated and cooled, to remain flexible and soft enough to be cut by a table knife, or flexible, hard, and elastic as the Toledo sword blade, or rigid, brittle, and hard, so that nothing but the diamond can continually cut its surface; the power again of cast iron to have its molecular texture altered by merely the rate at which it is cooled from the liquid state, through a range as great as that of steel, viz., from soft grey castings to white chilled ones—all present to us distinct, though well connected chains of facts, amongst the most marvellous, as well as the most important in their technological relations, that are found within the domain of metallurgy.

There remains yet another such train of facts, perhaps the most curious of any, viz., those which relate to the manufacture of what are called "malleable castings," that is to say, of the production of castings in iron which are white and brittle as if "chilled," when first cast, but which by a subsequent process are rendered soft, flexible, and tough, and presenting most of the physical properties of wrought or malleable iron. The production of malleable iron castings is a branch of iron founding which constitutes a very considerable and distinct European industry, and which employs a large number of workpeople, both in Great Britain and upon the Continent. In certain aspects it is second to no other branch of ironfounding in interest to the chemist and technologist; and yet it is remarkable how little is commonly known about it; how little has been published, of an exhaustive character, in modern days about it, and how scanty and inexact are the statements to be found about it in works, especially English works, on Metallurgy. Dr. Percy, in his "Metallurgy of Iron and Steel," dismisses the whole of the important subject in little more than a single page (p. 805), in which his sketch of the historical origin of the process is incorrect; his notice of the facts even of "the trade," most meagre and incomplete; and in which he does not even offer an attempt at any theoretical explanation of any of the facts of the process, of which he contents himself by stating, that "the gradual changes produced by this process are pretty remarkable." A much more complete account is given by Pelouse & Fremy in their "Traite de Chimie Industrielle," vol. iii. p. 290 to 294; but almost the same statements and misstatements will be found copied into every English, French, and German work on technical chemistry that notices the subject at all. M. Brüll, in 1862–63, produced a memoir to the Society of Civil Engineers of Paris, which, so far as it goes, is perhaps the best digest of the subject which has appeared, but it still leaves much to be desired. M. Brüll, in concert with General Morin and M. Tresca, has made a series of experimental researches at the Conservatoire des Arts et Metiers, Paris, on the tenacity, &c., of specimens of malleable cast iron; but the very nature of the process renders a far more extensive series, upon different scantlings, and treated in different ways, as well as cast from various "makes" of pig iron, necessary before the physical properties of malleable castings in iron can be said to be at all completely known.

We shall proceed to treat as fully as our limits will permit—1st, Of the history of the discovery and introduction of it as a branch of industry, under the title of Malleable Iron Casting. 2nd, Of the methods and principles involved in the manufacture. 3rd, We shall give some account of the actual state of the manufacture, and of its statistics as now carried on in Great Britain and abroad. And 4th, We shall offer some remarks as to the extensions of which it seems susceptible, and of the improvements or economies which its processes appear to admit.

Almost everywhere, and by all authors, the discovery of the change inducible in certain cast iron by long-continued heating out of contact of air, and frequently spoken of as "the decarbarizing of cast iron by cementation," is attributed to Reaumur. This, however, is beyond question a mistake. Reaumur was certainly the first to publish in print anything like a connected account of such a process, and he was the first who made and published a series of experiments with a view to discover what were the best methods of conducting the cementation, and with what cementing material it succeeded best. But he was not the first to discover the fact of the change, nor the originator of the process, which had actually reached the rank of even a manufacture before his epoch. In 1722 Reaumur published a work on iron metallurgy in which his earliest notions on the subject of softening cast iron, *d'adoucir le fer fondu*, occur. It was not, however, until after his death in 1757, and between 1774 and 1781, that his papers came into the possession of M. Duhamel de Monceau, by whom they were published in the 15th volume of the 4to edition, published at Neufchatel, of the "Description des Arts et Metiers" of Professor Bertrand, as a fifth part, or sequel to the able Vol. II. of that work, "L'Art des Forges et Fourneaux à Fer," by the Marquis de Courtivron and M. Boucher, Mem. Acad. Sciences.

From these memoirs chiefly, which are very voluminous, those of Reaumur alone, consisting of nine lengthy memoirs extending to over 300 4to pages, we gather the following as most probably containing the truth as to the early history of this curious invention or discovery:—

A traditional belief, or rather a sort of superstition, is stated not only by Reaumur, but by several other authors, to have long held sway amongst the workers in ornamental ironwork in France (that sort of fine hand-bcut and moulded wrought iron work which was employed for the *grilles* and *balustrades*, &c., of churches and palaces during the fifteenth, sixteenth, and seventeenth centuries, and which, for some time all but extinct, has been revived in our own generation both in France and England), that many of the *chefs d'œuvre* of commonly called wrought iron or smith's work, were not due to manual production with the hammer at all, but had been produced by *casting*, and by the conversion of the brittle cast iron, without change of external form, into tough malleable iron, by some unknown and presumed lost process, known to those ancient workers in iron who flourished and executed such ornamental works in iron, as those of the floreated hinges which cover the great doors of Notre Dame at Paris, or those of the cathedral at Amiens, and various others, all executed, probably, prior to the fifteenth century. The workman's tradition further stated that this art had been rediscovered, and again lost, several times.

Whether this tradition as to the factitious ancient floreated smithwork was right or wrong, the art of softening castings in iron so as to make them flexible was not quite a lost one in Reaumur's own early day. On the contrary, he distinctly states that the Sieur d'Handimont of Conches, in Normandy, had, with the pecuniary aid of several adjacent landowners, established a manufactory of such softened castings, which was at work for several years, and which was broken up at the death of the Sieur d'Haudimont. That manufactory preceded, by some years, two others which also existed in Reaumur's time—one at Cône, which seems to have been near Paris, and the other in the Faubourg de Saint Marceau of that capital. It appears to be impossible now to arrive exactly at the dates when these were in operation—the latter, Reaumur speaks of as having been commenced "about twenty odd years" prior to the time at which he wrote; but as these memoirs of Reaumur's were found amongst his papers after his death, and though they appear to have been read to the Academie Royal, were posthumously published, it seems impossible to be more precise as to the date than that it must have been not later than about 1720. None of these manufactories derived their knowledge of the processes they employed from Reaumur.

The Paris manufactories appear to have been broken up after some time, owing to the uncertainties said to have attended the results of the processes employed rendering a mercantile return impossible. The Norman one was discontinued at the death of the originator, as we have stated. From the son of this Sieur d'Haudimont Reaumur seems really to have learned the leading features of the processes that were employed in his father's manufactory. Reaumur says, in express words, "*Un fils de ce même M. d'Haudimont me fit l'amitie de me venir voir, et c'est de lui que j'ai su ce que je viens de rapporter du secret qu'avait eu feu son père*," p. 154. The works executed at Cône were ornamental brackets, balustrades, candelabra, &c., &c., and they are stated to have been finished frequently bright, or blued like steel, and relieved with gold, and valued for their delicacy and safety from fracture.

The general facts appear to have been known to Reaumur—that the castings when first made were hard and brittle, that the softening process consisted in covering them with some species or other of coating, or imbedding them in some particular material, and then beating them for a considerable time to a high temperature in close furnaces. These, and no doubt more or less of subordinate facts, he seems to have learned from M. d'Haudimont's son; and probably through other channels—amongst which may have been the Marquis de Courtivron, himself an ironmaster, and obviously a highly intelligent and well instructed man. What Reaumur really did, then, seems to have been to set himself to work resolutely upon the substrate of information which he had obtained, to find out experimentally what was the nature of the secret composition in which the castings were imbedded for cementation, and to what temperature, and for how long, it was necessary these should be exposed, in order to become malleable.

His pursuit of this is certainly not characterized by much method or insight. He, in fact, submitted hard white castings, as well as grey ones, to a red heat, immersed in all sorts of likely and unlikely materials: bone ash, black lead, alkalies, lime, limestone, gypsum, crude antimony, soot, charcoal, saffran of mars, sea-salt, nitre, corrosive sublimate, and a score of other heterogeneous things were tried—the results of heating with which he has given. He comes in the end to bestow a preference upon a mixture of limestone or quicklime, bone ash, and charcoal, as that which, as an imbedding material, gave the best results when the castings were heated with it in closed vessels.

Nor can it be said that Reaumur was very clear or successful, in the second and following memoirs of his "Third Part," in determining what sort of pig iron was best suited for castings intended to be afterwards cemented into a malleable state.

In fact, Reaumur has no just claim to be considered a philosophical discoverer in this case at all, as we shall more fully see when we shall hereafter treat of the actual reactions, so far as anything exact is even now known about them, which go on in making malleable cast iron. To the very end, he remained under the impression that the softening was due to some special reaction *due to the nostrum*—the material with which he coated or in which he embedded the castings before heating them. The notion that the effect might be produced by the prolonged heat, out of contact directly with air, and by that alone, never seems to have entered his mind. So far as he was a discoverer, therefore, he was simply an accidental one, and the high probability is that here, as in so many other instances in the history of the metallurgy of iron, *the fact* that white cast iron, by prolonged heat at a high temperature, is gradually rendered softer and darker in colour, and with an altered texture, had been again and again accidentally noticed by workers in crude iron; had been observed, more or less methodized, and technically taken advantage of, by various people at different times and places, as in the cases of the proprietors of the works at Cône, Conches, and Saint Marceau, but without any written information; and that at last some of the salient facts were hammered out, partly through inquiry, partly through a very blindly-conducted set of experiments, and made permanent and public property through the printed memoirs of Reaumur.

Whether the process in any form was pursued as a manufacture anywhere, or at any period between 1781 and the commencement of the present century, appears uncertain, if not unknown. The next trace we find of it is in the patent obtained in England, and dated 13th May, 1804, by Samuel Lucas, of Sheffield, in the county of York, refiner, "for a method of separating the impurities from crude or cast iron without fusing or melting it, and of rendering the same malleable, and proper for several purposes for which forged or rolled iron is now used; and also by the same method of improving articles manufactured of cast iron, and thereby rendering cast or crude iron applicable to a variety of new and useful purposes." In the words of the short specification, which may be found in *The Repertory of Arts*, second series, vol. vii. pp. 256, 257, the patentee says:—"The pig or cast iron being first made or cast into the form most convenient for the purpose for which it is intended, is to be put into a steel-converting or other proper furnace, together with a suitable quantity of ironstone, iron ore, some of the metallic oxides—lime, or any combination of these (previously reduced to powder), or with any other substance capable of combining with or absorbing the carbon of the crude iron. A degree of heat is to be then applied so intense as to effect a union of the carbon of the cast iron with the substance made use of, and continued so long a time as shall be found necessary to make the cast iron either partially or perfectly malleable, according to the purpose for which it is intended." If to be perfectly malleable, from one-half to two-thirds of its weight of ironstone, iron ore, or other substance will be found necessary; if only partially, a much less quantity may suffice.

Five or six days and nights will be in general found sufficient to continue the heat, which towards the close of the process cannot be too great. The proportion of the substances, and the duration of the heat, as well as its degree, depend not only on the nature of the substances, but on the nature or quality of the pig or cast iron employed, "a knowledge of which can only be obtained by experience." The cast-iron articles may be placed in alternate layers, he says, with the embedding substances; and these may be prevented adhering to the cast iron by a thin layer of intervening sand. He concludes by noticing that when the articles are small, a less proportion of the substances, as well as less degree and continuation of the heat, are requisite to confer the malleability.

This patent of sixty-four years ago has been in reality the basis of the whole now widely-extended art of the malleable iron founder; and it is an interesting fact, which we shall notice more at length hereafter, to find that the manufacture still flourishes in the same family, the nephews of the above Samuel Lucas still carrying on the works at the village of Dronfield, six miles from Sheffield.

What assistance, if any, Samuel Lucas had obtained from the memoirs of Reaumur, published in French, but not at that date, we believe, in English, even in abstract, it would be useless now to inquire. He had seen them work, probably from his mention of "lime." The probability is that his chief information was derived from actual trials, suggested probably by observations accidentally or incidentally made in the steel-cementing processes going on around him, and guided, to a certain extent, as the terms of his specification show, by the imperfect chemistry of the time. If we are to view any one whose name is upon record in connection with this art as its discoverer, certainly the claim seems to belong to Lucas; and, in fact, very commonly in France the opinion is heard to prevail, that the art of malleable castings is owed to England, and that as it now is practised, it was introduced from England about thirty years ago, viz., about 1830, or thereabouts. The manufacture was introduced undoubtedly from England into Belgium, as expressly stated by M. Franquoy (p. 127) in his prize memoir upon the progress of iron manufacture in the Liegeois country (Belgium). It was first established at Herbstal, in 1838, by MM. Lesoinne et Pirlot, by the help of English workmen, and became engaged on ironmongery—keys, locks, bolts, buckles, &c.—and it has now become in Belgium a vast trade, applied to a surprising variety of objects and purposes. A great number of the valuable or useful ends to which the process might be applied, which were clearly seen and some of them specified by Reaumur, have become realized. Very many uses which it was not possible he should foresee, have since been found for malleable cast iron, which is now employed for the materials used by saddlers and harness-makers, coachbuilders, lock-makers, gun-makers, pump-makers, makers of weighbridges and balances, and by cutlers upon a vast scale, as well as for articles entering as parts of small machinery, and to ironmongery employed for an infinity of builders' and domestic purposes, as well as in the fabrication of tools for manual use in a great variety of trades. One of its most extensive and curious, as well as valuable applications, is to the production of nails of all sorts for the soles of shoes and boots, and for coffin furniture. These are exported to France and Germany, as well as to Brazil and other countries, in incredible quantities from Staffordshire, and one of the largest manufacturers in this trade is at the present moment engaged in forming works upon an extensive scale at Rouen in Normandy.

Mr. Beverley Fenby has made some new applications of the material in the production of his patent locks, which, are being manufactured by machinery, and soon, no doubt, upon a vast scale, will produce quite a new vent for this material. A foundry at Paris, too, has for some time been engaged in casting toothed wheel gearing of all classes and sorts in this material, the moulding being done by machinery. The specimens of the manufacture exhibited last year at Paris were perfect in form and style of execution, and up to a pitch of 1 inch or 1¼ inch the toothed wheels appeared as tough as if of wrought iron.

Size sets a limit to the power of really producing by cementation any object in malleable cast iron, and the most skilful manufacturers of the heavier classes of malleable castings consider that practically this limit is reached with castings presenting considerable masses, which average more than about 2 inches in thickness between their opposite surfaces.

Latterly, a firm in Glasgow, Messrs. M'Haffie, Forsyth, and Miller, have engaged in the production, by some alleged secret process, of what they call malleable cast iron, which they profess themselves able to make into castings of any scantling, however great, yet still retaining the toughness and other valuable properties of cemented malleable castings. We are somewhat incredulous as to this, and apprehend that it will ultimately be found that the material cast by this firm is only by a loose use, if not an abuse of terms, called malleable cast iron at all. It is well known that the melting together in the cupola or air furnace of certain qualities of pig-iron, with a proportion of wrought or malleable iron, or of Bessemer or other steel, and with or without the addition in some form of manganese, produces a sort of material when cast, which is very like the so-called "homogeneous iron" of which so much was heard a few years back, and which, while possessing as high, if not a higher, coefficient of rupture as the average of ordinary cast-iron, possesses also a higher coefficient of extensibility. It is, in fact, a stronger and a tougher material, and in so far a better material for many purposes, such as spur gearing, screw propellors, &c., than ordinary cast-iron. But it rather tends to delusion, to call any such material, varieties of which constitute the matter of very many patents, such as those of Stirling, D. Price, and various others, by the name of malleable cast iron; *i.e.*, cast iron rendered malleable after it has been cast by some subsequent, separate, and distinct process; and that excluding mere annealing or slow cooling as a subsequent process, which it is well known tends somewhat to toughen and make malleable and flexible any common casting in iron.

We shall have occasion, however, probably to revert to this more fully in the following paper, in which we shall continue the subject of the manufacture of malleable cast iron, the *History* of which, we may say, we have now concluded.—Ed.

THE LATEST CLYDE-BUILT WAR-SHIPS AND DESIGNS.

As some of the earliest ironclads for the British government found their creators in the eminent firm of shipbuilders and engineers whose head has long enjoyed the reputation of being first and foremost in the North of all progress in naval architecture, so has the firm of Robert Napier and Sons since then been intrusted to giving birth to various engines of marine warfare for other nations. We have in former articles described the armour-clads which they constructed for the Turkish government; and now we have to write of two "turret ships" recently launched for the Dutch government. Without at all, on the present occasion, seeking an opportunity for discussing the merits that may be considered as belonging to the turret system, beyond stating that as in this country hitherto proposed to be worked and planted in the ship, we see reasons for grave apprehension as to the advantages alleged to belong to the turret system, and inclined to a well-designed fixed central battery armed with muzzle-pivoting guns, whether for the low-lying deck of a coast or harbour defending floating battery, or for the higher elevation necessary for a sea-going fighting ship, we may at once proceed to describe these last productions. The vessels are respectively named *De Buffel* and *De Tyger* (the *Buffalo* and the *Tiger*), the former being a "ram" and "monitor" combined, the latter a "monitor" merely.

Of the former vessel the dimensions are :—Length, 205 feet; breadth, 40 feet; and depth, 24 feet. Tonnage (builders' measurement) is 1472; and her load draught, 15 feet 6 inches. She is a twin screw vessel, fitted up with two pairs of return connecting-rod engines, with surface condensers, having a nominal horse-power of 400, but which can be wrought up to 2400. Of the latter the dimensions are—length, 187 feet; breadth, 44 feet; and depth, 11 feet 6 inches. Her tonnage (B.M.) is 1612, and her load draught of water 8 feet 6 inches. The *Buffalo* is by far the handsomer boat of the two, her lines and appearance generally—barring the turret, and the portentous "knife" for cutting an adversary in two projecting from the stem—being to the uninitiated eye much the same as those of a common screw steamer. The *Tiger*, on the other hand, is a peculiar, and the reverse of a handsome, craft. Broad and low, with a flush deck which in ordinary sailing is only to be 2 feet, and in action only 1 foot, above the water, she looks like a Titanic turtle asleep upon the surface, and one, too, which you wouldn't care about disturbing. The "turret," however, is the distinguishing feature in each, and is precisely the same in both. It may be described as a squat funnel, 6 feet high above the upper deck, and 22 feet in diameter. It is pierced in the present instances for two guns, and rests on a circular platform on the main deck, about 4 or 5 feet below. This platform, as already mentioned, is movable by means of machinery something similar to the well-known turning table for shifting railway carriages from one line of rails to another, and both in the *Buffalo* and

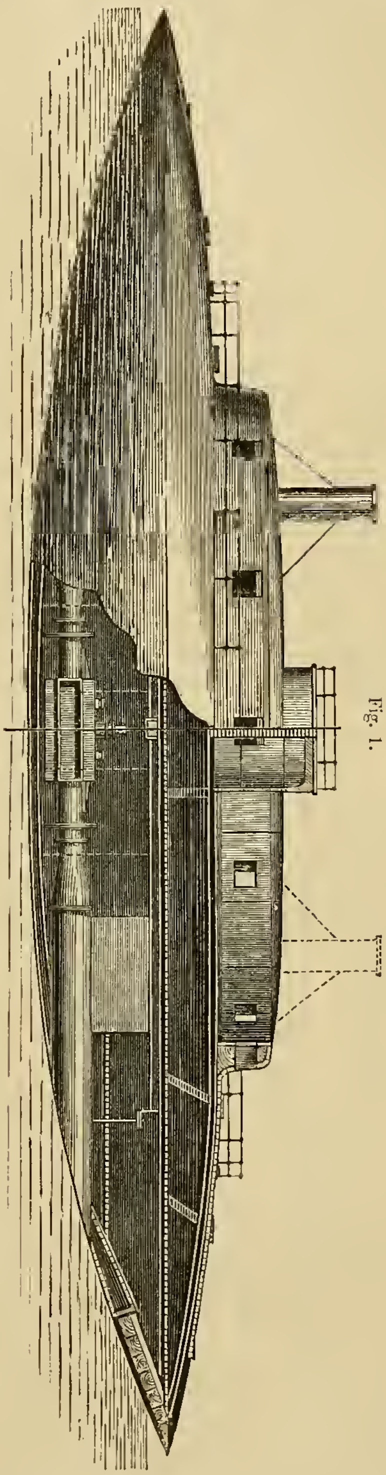


Fig. 1.

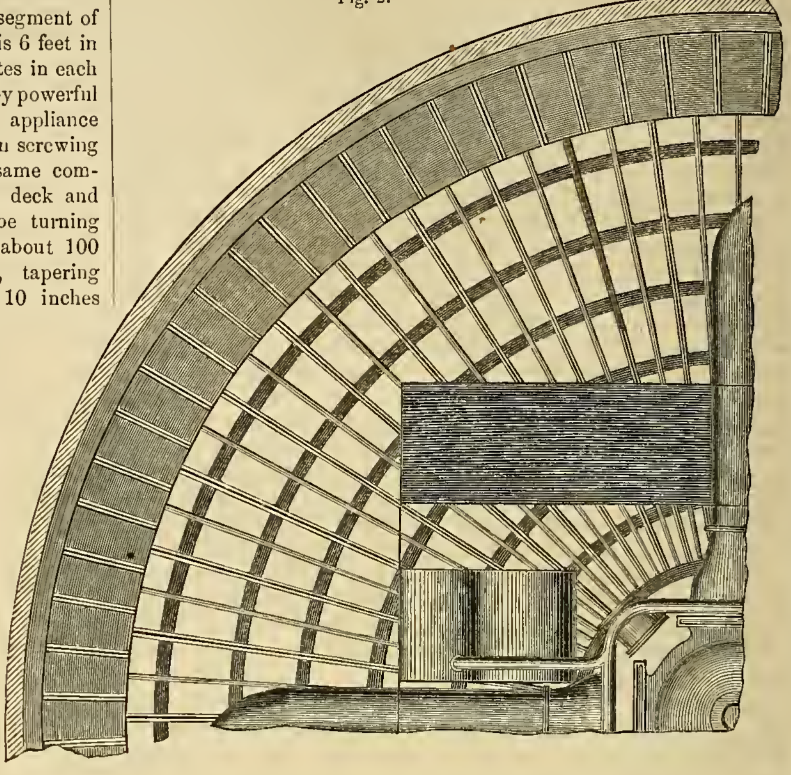
Tiger the massive turret can make one complete revolution in a minute. The turret—that is, the turret wall—is altogether 21 inches thick, composed so that before a ball striking it could damage anyone or anything inside it would have to pierce, first, a plate of malleable iron, 8 inches thick; next, 12 inches of solid teak-wood; and then another plate of wrought iron, 1 inch thick; in all, 1 foot 9 inches of the most solid and substantial material one could well conceive. Each of the 8-inch plates in question is 14½ feet long by 3 feet deep, forming a segment of one-fifth of the circle; so that, as we have said, the turret is 6 feet in height above the upper deck, and there are ten of these plates in each turret. They are secured to the teak backing, we may state, by powerful nut-and-screw bolts, with "elastic cup washers," a recent appliance which is intended to give at once tightness and elasticity in screwing up the bolts. In the *Buffalo* a low wall, of exactly the same composition and thickness as the turret itself, rises out of the deck and surrounds it, to protect the bottom of the turret and the turning machinery; while the outer skin of the vessel herself, for about 100 feet amidships, is composed of 6-inch plate armour, tapering off to 4½ inches forward, and 3 inches aft, laid on to 10 inches thick of teak amidships, tapering off fore and aft to 8 inches. It will thus be obvious that unless, as some believe, the force of projectiles be capable of development in a ratio far exceeding that of any resisting media, a craft like the *Buffalo* ought to be, in an ordinary way, shot-proof. Both vessels, we should add, are furnished with steering apparatus, situated down beside the engines, so that the operation of "picking off the pilot" or damaging the wheel would be a difficult one, when both are snug away far below the water mark.

As above mentioned, however, when in action that draught would be increased by 1 foot, thus leaving her flush deck no more than 12 inches above the water, the object, of course, being to present as little as possible of her sides, which are coated with 8-inch armour, to the fire of an antagonist. The means by which she can thus be depressed a foot at will are simple and expeditious. She is furnished with an inner skin, between which and the outer the water is left in, and her draught thereby immediately increased. The *De Tyger* is also a twin screw, her two pairs of engines being of the direct-acting horizontal pattern of 140 horse-power indicated, but capable of being increased to 680. As before remarked, she cannot be called handsome, and from her weight and construction it is difficult for a landsman to fancy how she can even float. If lacking the savage grace and agility, however, of her namesake of the forest, she possesses like strength and destructive power; while, having already been down the river as far as Greenock, it is demonstrated that she can swim in calm water at least. We have only to add that in every way both vessels are calculated to maintain the long-established repute, both as builders and engineers, of the eminent firm by whom they have been constructed. The Dutch government, too, would seem to have been desirous to procure first-class ships, and they have got them. Both the *Tiger* and the *Buffalo* are to be fitted up and "found" on a liberal scale, and in the latter especially the officers' quarters are almost luxurious in their details for such a vessel. Lastly, the *Buffalo* is furnished with five small boats, and the *Tiger* with four, one of each set being a life-boat, built on the very latest and most approved principles.

Messrs. Napier, we observe, have also on hand at present a contract from the British government for two large twin-screw armour-clad frigates, each of 3774 tons B.M., and to be named the *Audacious* and the *Invincible* respectively.

A rather singular but not entirely novel suggestion, which we may here mention, has emanated from Mr. John Elder, of the firm of Randolph, Elder, & Co. A short time since Mr. Elder embodied his designs in a paper read to the members of the Royal United Service Institution. This proposed ship is to be circular in plan, the bottom or hull, including the immersed section as well as that above it, being a segment of an enormous sphere. What may be termed the upper deck is also part of another partly spherical segment, flattened off to a plane platform, and supporting centrally a huge circular battery, constructed to mount ten guns. The vessel is to be fitted with jet propellors, capable of driving her in any direction by issuing through any one or more of four nozzles, as shown in the plan, fig. 2; and the extremities of the nozzles are to have deflecting plates applied to them, so that a rotary motion may be given to the ship; and Mr. Elder expects this to reach the rate of ten whole revolutions per minute, and as it has been proved possible to load and fire a heavy gun in one minute and a half, it is clear that in this space of time each of the ten guns would be brought to bear on any object under attack. Another object said to be aimed at by the rotary motion is to use the sharp edge of the two meeting spherical segments as a huge circular saw for cutting an enemy's ship. This, however, is perfectly absurd. We should naturally expect, from what has hitherto been laid down as the law of resistance to the passage of vessels through the water, that a vessel of this form would require the employment of a vastly greater power to drive her at any given rate of speed for a given displacement, as compared with any truly "ship-shape" vessel, but if we may rely upon the accuracy of Mr. Elder's experiments, the resistance for a given displacement is increased by only 10 per cent. over that of a vessel of the *Black Prince* model. If resistance is so much less than might have been expected, it is possibly in part due to the fact that in a sphere for a given displacement the skin surface immersed is less than with any other figure, so that the reduction is effected by a diminished skin resistance. As far as steadiness is concerned, and as forming a platform from which to fight guns afloat, there can be no doubt as to superiority in both respects with such a vessel as Mr. Elder has proposed, although we must confess that we do not hope for much practical good ever to be effected by using it as a huge floating circular saw. In the whole design, however, there are numerous points entitled to mature consideration, which we trust it may receive at the hands of those properly qualified to pronounce an opinion, although, like most other private designs brought before our Admiralty department, it will probably be shelved, and at some future time brought forward by some "official" as new.—V. D.

Fig. 2.



THE IRON INDUSTRY OF THE CUMBERLAND DISTRICT.

The historic revolutions which the iron industry of Great Britain has passed and is yet to pass through, as time has rolled and is still to roll on, based almost entirely upon the better or worse supply of fuel and ore, are full of interest and of import to all engaged in the iron trade. They are more especially so to the ironmaster, who would discern, as respects his own industry, "the signs of the times," and would endeavour to predict in what new direction the tide of manufacturing success may flow highest when it shall have left his own shores bare and dry. Once having its hives of industry in the natural oak and beech forests of Gloucestershire, and of Sussex and Hampshire, the iron trade passed with the transition from wood to coal fuel, to the coal-fields of the forest of Dean, and into Staffordshire and Shropshire. Then came the epoch of the great South Wales iron smelting, and saw the beginnings of that which rapidly became the mighty iron trade of Scotland. The Northumbrian trade followed, and that of Durham and Derbyshire, and of many scattered localities, which we here pass by. At length, thanks to long and plentiful demands, and in good part to wasteful and unsystematic working, Staffordshire and the whole midland region of iron industry began to find itself outstripped in supply and undersold in prices. Hot blast in Scotland and South Wales may be said to have finally robbed "the Black country" of its iron crown of supremacy worn for so long; and then came that which was for the moment the most wonderful expansion of iron wealth that England had ever known at one stroke—namely, the discovery and opening of the industry of the inexhaustible deposits of the Cleveland iron ores, and the now enormous iron production of the district about Middlesborough-on-Tees—one which, we may venture to predict, is destined yet to see far greater extensions than we already are amazed with. The North Wales iron trade may be said to date from little more than fifteen years back, and has expanded much, though not likely ever to keep pace with its two colossal northern companions upon the east and west coasts of England. Later still, dating not more than nine or ten years back, the great iron industry of the north-west, or of Cumberland, as it is commonly called, and which we might denominate the great hæmatite industry, has sprung into prominent existence, and is, we may say, certain to assume proportions co-ordinate with those of the Cleveland one. In the approximate future we already see that the Northamptonshire ores, which not more than about fifteen years ago were not known to exist by ironmasters, have a great future before them, whenever the methods of treating those brown hæmatites shall have become thoroughly understood, which as yet they certainly are not. We cannot but see, too, that the spathic iron ores of Exmoor, found largely in Devon and Somerset, and probably those of Northumberland, will be largely brought into play, and will determine the setting down of new centres of iron-smelting and steel-making industry, dependent upon the conditions of best supply of fuel, and of egress to market of the products. But these iron districts of the future we must pass by now, in order to give our readers who may not have had an opportunity of seeing for themselves, some notion of what has been done, and is ready to be done (if once trade and enterprise shall again revive), in the great Cumberland hæmatite district.

The "Lake district," one of the most delightful in our islands to the lover of merely fine scenery, and one of the very best for the renovation of health to the hard worker of mind, has now other attractions to whosoever visits it with the special knowledge of the chemist, the metallurgist, and the economic geologist. In its south-west corners it is no longer a succession of pastoral and agricultural hill and vale, sharp and rugged slate mountain, deep-cloven valleys with sparkling trout streams and winding hollows, bottomed by the glittering mirror of the quiet lake, as it all was so lately as Wordsworth's day, but along with all this, as yet unimpaired and undimmed by smoke or "cinder tips," it has also become a hive of industry, with railways threading its valleys, linking together vast iron-smelting works, carrying an enormous traffic in fuel, ores, and products, as well as food to feed a swarming multitude of workmen, nearly all of whom are immigrants from the older iron districts, and coming down upon the western sea at seaports, some of which, like that of Barrow-in-Furness, have sprung up with the rapidity and almost to the magnitude of American towns, or others, like those of Whitehaven, have enlarged their borders and thickened their population, so that Wordsworth himself, or Southey, or other of the "lakers" of one generation ago, were they to revisit "the glimpses of the moon," would not recognize them again.

The hæmatite ores of Cumberland have been known, and even to a small extent worked, for ages. If we enter the district, as it is best to do, from Lancaster (a curious example of a place of ancient dignity and importance passed by and forgotten in the modern race of progress, for reasons which we must not stop to speculate upon), and, taking the system of well-worked and well-managed Furness railways, make our first halt at the delightfully placed and tasteful hotel at Furness Abbey, which the railway company has constructed upon a lease from the Duke of Devonshire, which includes the ancient abbey, and there while away an afternoon studying Pain's history of the abbey amidst its glorious ruins—we may find that, amongst the enormous possessions of the abbot and monks of Furness, were mines of iron ore, and of the working of these they took a liberal toll, as early probably as the middle of the fourteenth century. But the existence of iron ore was only known in a few spots; the working of it was wholly by wood fuel, or possibly in part by peat; and the industry must have been, down to long after the dissolution of the monasteries in 1550, a very small affair—much like what goes on even still in the Southern Appenines and some parts of Sardinia and of Spain. The iron made, however, must have revealed its fine qualities, due to the purity both of the fuel and the ores, for the manufacture never seems to have completely died out; and during the latter part of the last century and the early years of the present one, a good deal (according to the then notions of much and little) of iron was made in Cumberland with charcoal as fuel; and the pig iron of Ulverstone was in valued reputation for certain purposes, and the Back Barrow charcoal bar iron highly appreciated at Sheffield by the steel converters, and by blacksmiths known for its workable properties in the fire all over Great Britain.

The smelting works, however, were small, and the total supply very limited; and had not mineral fuel come to take the place of charcoal, the iron trade must have disappeared here as completely as it has done from Sussex or Hampshire. The Ulverstone and some other hæmatite pits had long been known, and more or less of this rich ore had formed an article of export to the ironworks of Scotland, of the midland districts, and of South Wales, as in fact is still the case, the ore being worth at the pit from 10*s.* to 13*s.* or 14*s.* per ton. When pure it may contain 70 per cent. of iron. There are two sorts of hæmatite worked in the district extending from north of Whitehaven to Ulverstone, or a little south of it, in mercantile parlance called "hard and soft" hæmatite respectively. The hard is chiefly from the northern sections of the country, and may be of compact subcrystalline masses of reniform or "kidney ore," or of less coherent hæmatite, through which is diffused a good deal of quartz in the state of fragments or sand crystals. This hard ore is frequently found in compact beds, which require the wedge, or blasting to dislodge them.

The soft ore, which is greasy and unctuous to the finger, from disseminated scales of mica, or of micaceous iron ore, or of both, is often dug out of the beds as a heavy red clay in appearance to the eye, and this is usually far less rich in silica, and contains earthy bases—clays in fact. Both are, in a manufacturing sense, nearly pure anhydrous sesquioxide of iron. In minute quantity, however, several foreign metals have been recognized. In assaying the ores, lead, cobalt, tin, copper, and arsenic are said to have presented themselves in traces; and in the dust of the flues through which the hot gases from the blast furnaces at Barrow Works are conducted, a very considerable proportion of titanic acid is found.

The ores, as taken for assay, contain a very small proportion of manganese in the state of protoxide, and generally in extremely minute proportions, alumina, lime, and magnesia, the three bases together not making 1 per cent. The pig iron made by mineral fuel from these ores, the flux being limestone, contains from 2 to about 3½ per cent. of carbon, the far greater proportion of which is uncombined graphitic carbon, from 2½ to rather more than 3 per cent. of silicon, from 0·10 per cent. to none of sulphur, from 0·02 to 0·08 of phosphorus, and from 0·05 to 0·15 of manganese. These are in round numbers the normal constitutents, with occasional traces of the metal above stated as found in the ores.

From the above statement of the constituents of these present Cumberland pig irons, it will be obvious that their steel-making tendency, *cette prepension acierieuse*, as a French metallurgist has called it, of the Cumberland, and indeed of all hæmatite or micaceous ore, as the Swedish irons, cannot arise from the presence of manganese, as has been repeatedly popularly surmised. There can be no doubt that the main reason why they are so well suited for steel making is from the conspicuous *absence of foreign materials.* With more reserve it may be conjectured that the molecular arrangement of pig iron, made from hæmatite or micaceous ores, has some definite, though as yet unknown, connection with that of steel, which gives the suitability to the raw material.

The ascertained producibility of good pig iron from hæmatite ores alone, by means of mineral fuel, which we believe first was assured in the neighbourhood of Whitehaven, gave the first great modern impetus to the Cumberland district; but its subsequent rapid expansion has been dependent upon the facilities given by the new harbours, and by the Furness system of railways, for the transport of fuel as well as ores and products. The hæmatite beds, here as in Westphalia, occur in the carboniferous limestone, but pass into the red sandstone and into the slates, though rarely. Their existence in Cumberland seems almost of boundless extent, and their diffusion most remarkable; nothing can show this more strikingly now, than the innumerable directions in which one sees trial pits or working ones opened upon the hill sides. So rapidly is this extending, that within a few years the beautiful country between Ulverstone and Cockermouth or Whitehaven will have its rural and picturesque character seriously marred by surface heaps, gins, and pit waste, scattered almost as thickly as in the Black country. There are many great ironworks now in the district, just at present none of them fully employed, and all working for stock, more or less.

The Barrow Ironworks may be viewed, however, as the most important, and as the type of the whole. They are established and worked as the Barrow Hæmatite Steel Company (Limited), with a capital of a million, the chairman of the directors being the duke of Devonshire, James Ramsden, Esq., being the managing director, and J. F. Smith, Esq., C.E., the actual manager—a gentleman of high intelligence, accurate information, and great energy, under whose conduct these works have grown and prospered from the commencement, and under whose guidance we recently spent a day with much pleasure in examining them. About ten years ago Mr. Smith and his earliest partners started with one blast furnace upon a piece of waste beach, upon the shore opposite Barrow Island, the chief inducements next to the supply of ores from their own pits situated about four miles off, being the cheapness of the land, and the assurance of ample space for slag and cinder tips, all usefully put out in reclaiming land from the sea, and the capability of bringing fuel to the spot by sea. Barrow-in-Furness was then a village adjacent, of scarcely 1000 inhabitants, not more probably than five-fold the population that it held at the time when the commissioners of

> "King Henricus Octavus,
> Who took more than they gave us,"

as the monkish doggerel has it, came down to take possession of Furness Abbey.

It is now a bran new, thriving, and pushing seaport town of above 20,000 inhabitants, with several churches and meeting-houses, news-rooms, and what not; and a magnificent line of docks and quays, along the entire two miles in length of which the Furness railways run, and with fine deep water at top of tide. Along these docks engineering works and foundries, boiler yards, ship-repairing establishments, and timber yards, with saw mills, have become established as inevitable adjuncts of the great ironworks which form the sun and centre of the whole system. Steam-boats to and from Belfast in Ireland now start to and fro every day, and are in direct communication, for passengers, &c., with London, through the Furness and Midland systems of railways.

All this has been the work of ten years. The Barrow Ironworks now consist of eleven blast furnaces, with space for as many more—a complete system of well and symmetrically arranged blast engines, and all the other adjuncts of smelting works upon this large scale. Everything strikes the eye of the practical observer as indicating works constructed from the outset upon a consistent plan and with ample capital; nowhere does one see that bit by bit creeping on, and those sordid old makeshifts of plant, which characterize so many of the old establishments of these countries, which have grown by degrees and out of their own slowly made profits. We know not how far the information may be correct, but we have heard that the larger portion of the capital which has been devoted to the extension of these vast works has come out of their own profits, and to a great extent out of the profit of the sale to other ironworks of the hæmatite from their own pits. The fuel employed in the blast furnaces is coke obtained mainly from Darlington and its neighbourhood, and brought by rail. The blast furnaces are not nearly as large and lofty as those of the Cleveland country, and, in fact, those very large furnaces would probably not answer here, where the refractory character of the ores demands an intenser temperature than does the sub-oolitic clay ironstone of Cleveland. The blast furnaces are cylindrical, and are worked with open tops, the gases being taken off without the need of closing the tops, by the peculiar method patented by Mr. Smith, the manager. The gases thus taken off are employed wholly in raising steam in the several parallel ranges of boilers for the various blast engines, for which no other fuel is employed. The educts are finally drawn away into one or other of several large and lofty chimney stalks, the powerful draught of which forms part of the method of Mr. Smith, by which the waste gases are sucked out from the blast furnaces without the necessity of closing the tops. Hot blast is employed in every case, the heating pipes being of the inverted ∩ form, and the temperature of the air raised to that of iron visibly red in daylight. At present some of Mr. Chamberlain's patent blast heaters are being constructed with a view to greater durability in the heating pipes, and less liability to leakage while in blast. Water twyers, of course, are employed. The fuel by which the blast is heated is small coal, there not being gas enough produced from the blast furnaces. Siemens' gas furnaces are also in extensive use both for this and the purposes of the steel works. The sand beds for pigs are not under cover. The whole of this vast range of plant stands in parallel ranks; at one side the sea, with the lofty range of chimney stalks, which Mr. Smith has built directly upon the deep bed of sea sand upon the shore, covering up round the bases to the depth of some 15 or 18 feet with cinder and slag, so as to keep the sand unmoved; then the grand range of blast engines and boilers, the latter all cylindrical, some with some without tubes or flues; then a space free for tram or railroad way all the length; and then the lofty and imposing range of blast furnaces themselves, with all their adjuncts; and then at the other side of these and parallel to their range, the line of the Furness railways running into all parts of England and down to the Barrow port and docks, and northward up to Whitehaven, Maryport, Carlisle, and into Scotland. Nothing can be finer, in a commercial sense, than the situation.

Each furnace produces about 500 tons per week of pigs, but can be pushed up to 800 tons. The iron made, that which may be called No. 1, is a fine, clear, grey, crystalline iron, with much micaceous carbon diffused, and not unlike some of the best brands in appearance of Scottish, or of Beaufort (South Wales) iron. Every variety of close grey, mottled, and white pig, is also made. The iron is so piled and assorted when taken from the sand beds, that a mixture of numbers, and a known and as nearly as possible invariable one, can be had day by day for use in the Bessemer converting vessels, so as to better insure uniformity of result in steel. Crossing over the Furness Railway upon an iron bridge, we are in the midst of the steel works and rolling mills and hammers. Two vast buildings, also parallel to the railway, and adjoining each other at one side, extend about 800 feet each in length by about 160 feet in width, iron-roofed, with curvilineal roofing, and ample top lights. The whole produce of the establishment is devoted either to pigs for sale, or if not, to their manufacture into Bessemer steel in rails, bars, plates, &c.

For all this the plant is truly magnificent. In the nearer shed to the blast furnace are *ten* Bessemer converting vessels, each capable of working off 7½ tons of iron at once; all these have their own special air furnaces or cupolas for melting the pig and the spiegeleisen, with the hydraulic, or in some instances steam cranes, for manipulating the converting vessels, ladles, ingot moulds, &c., and also their own air blast engines. There are eight very large steam hammers for operating upon the ingots, which are all reheated in Siemens' gas furnaces, the powerful and *benign* heat of which at once attracts the eye of the practical ironworker. The trains of rolls, with the fine vertical cylindered beam engines (with wrought-iron and hard-timber connecting rods) by which they are driven, for bars, plates, sheets, and rails, are all admirably arranged, and the room around everywhere ample.

The subordinate machinery for the completion of steel rails is arranged in a very masterly manner. The steel rail before cooling is sawed off to the approximate length. The rails are then fixed in large parallel ranks, and have their ends planed off to precise length, after any crookedness or twist has been taken out under the gentle but irresistible suggestions of one or other of four eccentric driven plungers, so arranged that, on throwing in or out a movable block above the rail being operated on, any degree of bending pressure, or in any direction, can be given, as the eye of the workman requires. A considerable proportion of the precautions which in our last part of this journal we indicated as needed to insure uniformity of result in the manufacture of steel, we found here in use. Every plate rolled, when the waste ends are shorn off, has a piece of one of these cut out, marked and doubled up short by an overseer with a hand hammer; if it will not so double up cold, the plate itself is laid aside.

The plates are all annealed in furnaces specially prepared; but the temperature dip not appear to us to be high enough to insure the best effect. When annealed, portions taken at random are again tested, and now in the testing house—a fine separate building, fitted up with a powerful and exact testing machine, with balance levers, indices, &c., the power being by hydraulic cylinder, and all under the control of one foreman, who knows nothing of the plates or rails that come to him to be tested except by the marks upon them. The company is ready to guarantee an average breaking strain for their deliveries of steel plates, bars, angle and T forms, &c., of from 30 to 32 tons per square inch, with an average elongation at fracture of about $\frac{1}{5}$ to $\frac{1}{7}$ of the unit length, and that no plate or bar shall fall more than two tons below the guaranteed average. Mr. Smith is of opinion that a higher coefficient of rupture than 40 tons per square inch is unadvisable in the present state of manufacture, as although that or a far higher coefficient may be procured, it is so at a more than proportionate loss of elongation, *i.e.*, of toughness in the steel; and he rightly views a fixed moderate ultimate limit of strength, with a large elongation, in other words, a high value for the coefficients, T_e and T_r, as that which ought to be looked for by the engineer employing steel in his structures. In this we ourselves quite agree, although at the same time urging upon the steel maker that his business is to exalt the breaking standard to the highest point he can, while keeping it combined with a large, at least a sufficiently safe, coefficient of elongation. We saw with some surprise specimens of bolt steel which had been pulled asunder under a strain of 32 tons per square inch, and the ultimate elongation of which was as much as $\frac{1}{6}$ the unit, or 2 inches to the foot, a degree of toughness which we did not previously believe procurable with Bessemer, or indeed any other steel of that strength.

In watching the changes of the flame from the converting vessels, it was interesting to remark the distinctions in character observable, as compared with the Bessemer process as conducted in Sir John Brown's Works, upon irons chiefly not made from hæmatite. With equal force of blast, the time of total conversion seems, per ton of iron, rather longer with hæmatite iron. The flame from the converter is duller at first, and for a considerable portion of the time, and there is throughout the process less belching and throwing out of iron; then towards the latter end the flame is even more intensely dazzling and brilliant, and with greater suddenness becomes thin and transparent at the moment when the conversion is complete. The spectroscope, of which so much was once talked as a shop tool for directing the workman in the converting process, seems neither used here, at Sheffield, nor anywhere else in this country, though still applied now and then as an instrument of research; the practical eye becomes an abundantly exact judge of the moment when the blast may be thrown off. For the furnaces used in the various heatings of the steel in the progress of working, nearly all being Siemens' gas furnaces, nothing but the very best sulphur-free Wigan coal is employed. A more infusible fire-brick than they have yet been able to command for these furnaces is still a desideratum with them.

Separated from the rolling mills by a wide, and for the present, nearly unoccupied yard, is a noble range of offices and dwellings for sub-managers, &c., through which is the only entrance to the works from the public road. Amongst the other adjuncts of this pile is a well-arranged chemical laboratory, with two young chemists, whose sole employments are to assay the fuels, ores, fluxes, products, and educts of the works, and to conduct such trains of experimental research, with a view to the improvement of the manufacture, as may be suggested by the manager.

The slags vary much in colour which come from the blast furnaces, probably indicating that the amount of silex and of clays naturally present in the hæmatite ores differ at times considerably, and necessitate a somewhat tentative variation in the supply of limestone flux. The normal slag is a yellowish ashen gray; but black slag, like obsidian, but occasional deep blue gray, and even bright orange amber masses of olivine may be seen on the tips. We are not aware whether the whole suite of these hæmatite slags has been submitted to any rigid chemical examination. It would be much to be desired.

Such is a very cursory and imperfect sketch of the Barrow Iron Works, or rather Steel Works, for that alone they deem their proper trade product. Than those and the other works of the neighbourhood, and the district generally in which they are all situated, we know of nothing at present, in England, better worthy of the notice of the metallurgist and the iron master.—Ed.

COIN AND COINING.

By Joseph Newton, Royal Mint.

(*Concluded from page* 72.)

In the series of papers on "Coin and Coining," of which this is the last, the whole of the processes of the art of money-making as practised at the Royal Mint of Great Britain, have been explained and illustrated. There remains, however, a chapter to be written in connection with the subject which it is hoped will be found at least as interesting as those that have preceded it, and which is certainly an essential supplement to the series. It has reference to the engraving and manufacture of coining dies. The die department of the English Mint is entirely distinct from the coining rooms of the establishment, although located within its walls. It comprises offices and workshops appropriately fitted for the various operations to be carried on therein. Forges, lathes, furnaces, powerful screw presses, annealing pots, and numerous other appliances of a less important character, make up the fitments of the die department.

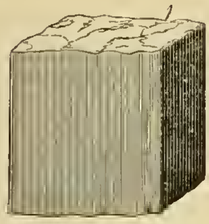
From an artistic point of view the engraver's studio is of course the centre of interest in relation to this branch of the Mint, for there the designs for the coinage of the realm are conceived and realized. It will be conceded, therefore, that this is the natural and proper starting place for a full description of dies and die-making. For the sake of elucidating the subject more completely, let it be supposed that the Mint engraver has received instructions to prepare dies for a totally new denomination of coin, as, for example, a "Victoria," or five shilling gold piece, to take the place of the obsolete and cumbrous silver crown, and to institute which would not be an unwise movement on the part of the government. Then the engraver will proceed to furnish a few designs for the ornamentation of the coins, both obverse and reverse. These are first drawn and carefully elaborated on paper for submission to the Queen, the Chancellor of the Exchequer, and to such other advisers as Her Majesty may think it proper to consult. A selection is thus made of those devices which appear to be most appropriate, and their transference to steel follows. As the subsequent operations are identical in all respects, as regards both obverse and reverse dies, it may be well for the present to confine attention to the obverse die only. The artist will next direct two pieces of steel to be cut from a square bar of that metal and forged into round form. These have to be annealed to the fullest extent of which steel is capable, and then turned up in the lathe. One of them has a flat and smooth-faced end given to it, whilst an end of the other is made to represent a flat cone. The flat-ended die block is that upon which the engraver first operates. He etches upon its turned surface a *fac-simile* of his approved design, and then commences the real work of engraving it in intaglio. This is a process which demands all the skill and patience of the artist, and not unfrequently many weeks' labour is expended in perfecting it.

Proofs are repeatedly taken in wax and in soft metal as the task progresses, and at length, after innumerable touchings and retouchings, the features of the queen are faithfully depicted on the obdurate material. Finally, the first die, subsequently to be known as a *matrix*, is passed from the engraver's hands, and then follows a trying ordeal for the minute but elaborate and beautiful production—it must go through fire and water, or in other terms, be hardened. Hardening steel for ordinary purposes is a simple process, but this, as may be imagined, is comparatively complex and attended with some risk. The preservation of the delicately engraved and fine lines of the royal portrait from the action of the antagonistic elements just named, is of the highest consequence. Hardening is therefore a crisis in the history of a die matrix. To prevent defacement the engraved device is shielded by a mask of paste, composed of oil and powdered animal charcoal, and which fills every interstice of the work. Sometimes an iron ring is shrunk on to the die at this juncture, to prevent the risk of its fracture during expansion and contraction. The matrix is next placed in one of Morgan's patent plumbago crucibles—which are generally used at the Mint for melting gold and bronze—with its face downwards, and buried in animal charcoal. The crucible and its precious freight is then deposited in a furnace, and kept there until the whole is brought to the colour of Kentish cherry, a period of about an hour. The die is then disinterred by aid of a pair of tongs and plunged at once into cold water. The manipulator, still holding it by his tongs, agitates the matrix to and fro in the fluid until hissing and sputtering cease. He listens also attentively for any musical note or, technically speaking, "singing" which may be given forth, but which the engraver would be sorry to learn had been heard, for it would indicate that the die had "gone" in the hardening.

At the Mint such a catastrophe as this seldom or never happens, thanks to the excellence of the steel supplied by Messrs. Turton & Sons, and its judicious treatment at the hands of the die-hardener of the royal establishment. In the case to which we are referring, let it be imagined that the work of hardening has been successful, then the black mask is removed, and the "table" of the die is polished by the friction of a revolving disc of iron upon which a film of flower emery and oil has been laid. Then comes the tempering process, which is effected by placing the die upon a bar of red-hot iron and keeping it there until it assumes a pale straw colour, when it is plunged again into cold water. The matrix is now complete and ready for duty.

The second block of steel is by this time softened and adapted to receive an impression. Both are thus prepared for the press, to which they are forthwith conveyed. The matrix is firmly fixed by set screws, and with its face downwards to the rising and falling vertical screw pin of the machine. The conical-faced block is placed on the bed of the press, immediately below the matrix. By means of fly-arms and the application of muscular hands the screw pin and matrix are raised to a height of two or more inches, and then released. The pitch of the screw-pin being very coarse (a treble thread of 5 inches), the pin descends rapidly with the matrix. This last impinges with force upon the annealed block of steel below it, and if the engraving be not of great depth, as in the proposed "Victoria" coin it would not be, a transfer in relief of the design of the matrix will be found on the face of the lower block or "puncheon." This in fact is effected by sheer pressure in all instances, although where the work is of much depth two or three press thuds must be given to make the transfer complete.

1



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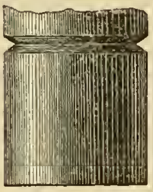

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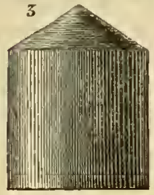

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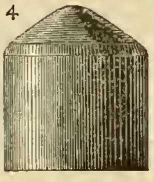

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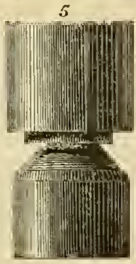

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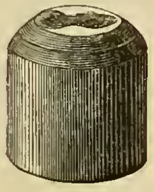

When this is accomplished the matrix has achieved its mission, and is placed in the custody of the engraver. The puncheon will have heavier duties to perform, as will presently be seen. It is first hardened, polished, and tempered in the way described, and then delivered into the hands of the die multiplier. In respect of the reverse matrices and puncheons similar operations, as has been observed, are performed, and, of course, there are two matrices and two puncheons for every denomination of coin struck at the Mint.

The labours of the die forger have next to be called into requisition, and many rectangular bars of steel are deposited in his store. These vary in size in accordance with that of the dies to be produced from them; and before use they are scrupulously examined and tested. There are two main reasons for using material of the choicest brands in the manufacture of dies. The first is that the fine lines of the engraver may be brought out with distinctness upon its surface; and the second, that it shall withstand the hammering to which it must be exposed in the coining press. Without minutely describing the tests to which die steel is submitted before use at the Mint, it may be stated generally that that which exhibits a moderately fine grain, is of uniform texture, and when polished is free from spots, is the best.

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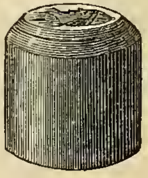

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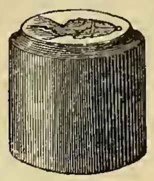

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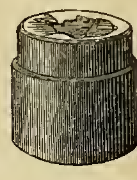
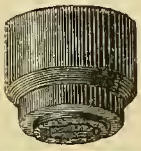


The die forger, having selected from his stock a suitable bar, heats one end to redness, and then cuts a piece off it, and which at this point forms almost a cube, as seen in fig. 1. This, after another heating, is worked into cylindrical form, and in fig. 2 it is shown at this stage, with a nick on its circumference, which will be presently developed into a cut completely through, and after further working will resemble diagram fig. 3. Thus bar after bar is treated by the smith until he has accumulated a large quantity—in fact, many hundreds of blocks.

11



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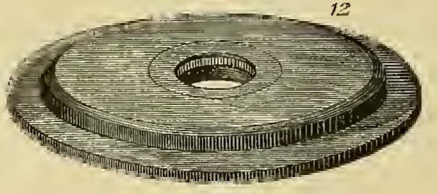

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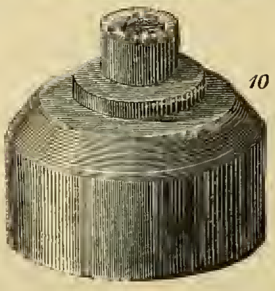


Owing partly to the severe hammering to which the embryo dies have been subjected, they are at this stage very hard, and in order to prepare them for the press, it becomes necessary to anneal them; this is effected by placing them in batches in annealing pots, covering them with powdered animal charcoal, and depositing them in furnaces. In these they are brought to a red heat, at which they are kept for several hours, and then allowed to cool gradually in ashes from the furnace. The turning shop is their next destination. Here they are one by one placed in the lathe, and "topped"—that is to say, the ends intended to receive the impressions are turned flatly conical. After this operation they have assumed the form depicted in fig. 4, and are ready to receive whatever imprint may be given them. The die-multiplying press is the apparatus employed for stamping them. In describing the mode of getting up matrices and puncheons this press has been referred to already, but now its results are reversed. The puncheon is attached to the press screw with its face downward, and a topped die is placed under it. The screw is raised by the fly-arms and manual exertion, and then thrown down until the puncheon meets with the softened steel block below, and to which it communicates its impression in intaglio. This condition fig. 5 illustrates. Fig. 6 shows the partly formed die when the puncheon is removed; and figs. 7 and 8 the blocks depressed until the impressions on their surfaces are completely sunk. The apex of the cone has in each case been driven by main force into a flattened form, and presents a *fac simile* of the matrix. Other blocks are submitted in succession to like treatment, and thus dies are multiplied by wholesale.

After this ordeal of pressure, the whole batch is again annealed, and removed to the lathes of the turning room. With extreme care each die is now turned to a gauged diameter and height, and this state is illustrated by fig. 9. To be exact, however, it must be stated that only one die of each pair (obverse and reverse) has to be turned with a long neck, as will be presently seen.

Hardening, polishing, and tempering follow, and then the long-necked dies are ready for fixing in bolsters or beds. A die of this description is represented by fig. 10, and a short-necked die at fig. 11. Between the two is seen the milled steel collar, fig. 12, which, when the operation of coining is going on, works up and down upon the neck of the lower die, and forms a mould for the edge of the coin. The upper die, in its descent upon the disc of metal to be stamped, merely dips into the collar, as it were, and therefore does not need a long neck.

The action of the coining press has been before explained, and it only remains to be said that each pair of dies lasts on an average one day, and gives impressions to about 25,000 coins of any denomination. As there are eight presses in the mint, it will be evident that nothing short of a system of a die multiplication such as has been explained could furnish a sufficient supply of dies for the purposes of the imperial coinage.

The staff of officers and workpeople employed in the die department is very small, and the duties, like those of the coining rooms, though interesting, are somewhat monotonous. Attached to this branch of the Mint is a small museum in which matrices, puncheons, and dies of past reigns are preserved. The oldest die in this place has the date 1272 in the *exergue*, and it is an excellent specimen of engraving, for the period. The dies of the celebrated *Simon* petition crown, *temp.* Charles II., are also to be found on a shelf of the Museum, as, indeed, are many other curiosities of a numismatic kind. The present resident engraver of the Royal Mint is Mr. T. J. Minton.

Perhaps at a future and not distant time some archæological facts in relation to the science of Numismatics may be afforded to the readers of the *Practical Mechanic's Journal*, in which case the ancient modes of coining (curious and primitive as they were) will also be noted. For the present it is hoped that the main points in the arts of money and die making, as practised in modern times, have been sufficiently elucidated.

ALUMINIUM BRONZE.

This alloy is composed of copper and aluminium in the proportion of 90 parts by weight of the former and 10 parts of the latter, or, when estimated by bulk, of 60 parts of copper and 40 of aluminium. The colour of the bronze closely resembles that of 18-carat gold. Morin believes it to be a perfect chemical combination, exhibiting, unlike gun-metal or brass, a decided homogeneousness, its preparation being also said to be attended by a development of heat greater than seen in the manufacture of most other alloys. The specific gravity of this bronze is 7·7. It is malleable and ductile, may be forged cold as well as hot, but is said not capable of being rolled; it may, however, be drawn into tubes. That it is extremely tough and fibrous is proved by the fact that when drawn into wire it supports a weight more than three times that of the best malleable iron; and as to its elasticity, it is stated by Tresca that the coefficient of elasticity of aluminium bronze (the cast metal) is half that of the best wrought iron. This coefficient is double that of brass, and four times that of gun-metal, under the same conditions.

Aluminium bronze, when exposed to the air, tarnishes less quickly than either silver, brass, or common bronze, and less, of course, than iron or steel. The contact of fatty matters or the juice of fruits do not result in the production of any soluble metallic salt, which highly recommends it for various articles for table use. Prolonged contact of strong acid will undoubtedly exert some action, but then it must be remembered that even silver, under similar conditions, is also attacked.

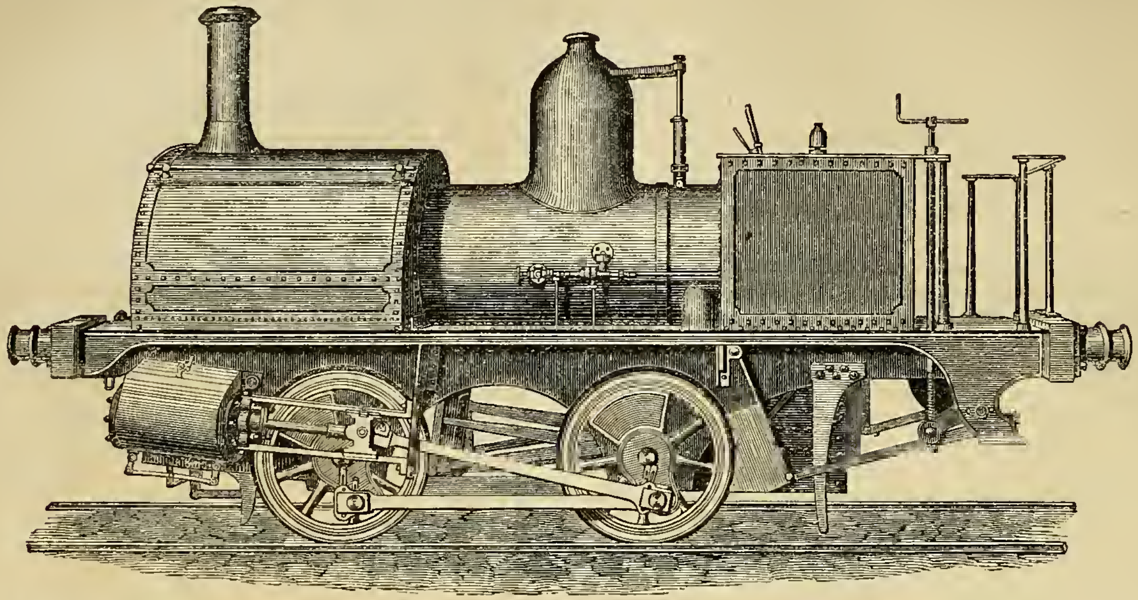
The uses to which aluminium bronze is applicable are various. Spoons, forks, knives, candlesticks, locks, knobs, door handles, window fastenings, harness trimmings, and pistols, are made from it; also objects of art, such as busts, statuettes, vases, and groups. In France, aluminium bronze is used for the works of watches, as also watch chains and ornaments for ladies. The cost of these articles is less than that of the best plated ware, and replating is of course avoided. Its application to machinery would have been greater were its cost less; this, there is little reason to doubt, will yet be reduced; but it was long since proposed by locomotive engineers to apply it for the bearings of the journals of engines, and for pinions and running gear it is said to have proved superior to all other metals.

M. Hulot, director of the imperial postage stamp manufactory in Paris, uses it in the construction of a paper-punching machine. It is well known that the edges of best tempered steel become very quickly blunted by paper. This is even more the case when the paper is coated with a solution of gum and then dried, as in the instance of postage stamp sheets. The sheets are punched by a machine the upper part of which moves vertically, and is armed with 300 needles of tempered steel, sharpened in a right angle. At every blow of the machine they pass through holes in the lower fixed piece which correspond with the needles, and perforate five sheets at every blow. Hulot now substitutes this piece by aluminium bronze. Each machine makes daily 120,000 blows, or 180,000,000 perforations; and it has been found that a cushion of aluminium bronze was unaffected after some months' use, while one of zinc bronze is useless after one day's work. There can be little doubt but that ere long, as its production is cheapened, we shall find this very beautiful in appearance, and mechanically highly important alloy, largely used in rapidly-moving parts of many classes of machines.—V. D.

RUSTON, PROCTOR, & CO.'S TANK LOCOMOTIVE.

This engine, which our eye fell upon last year at Paris as being a particularly well designed tank engine for contractors' use—greatly superior to the generality of these unsightly contrivances which may every day be met with in this country and abroad, is well worthy a short notice at our hands. The tank is placed just as it should be placed in all tank engines, wherein the fire-box overhangs the rearmost axle, and by its position, as the engraving shows, constitutes, when full, a fair counterbalance to the otherwise unsteady movements and axial oscillations or pitchings of the boiler, chiefly produced by the overhanging weight of the fire-box. We consider, however, that the makers might, with obvious advantage, have made the tank deeper—the larger capacity so offered for the counterbalancing weight of water being less speedily reduced—as it would then be possible, under the short runs to which contractors' engines are usually submitted, to keep enough water in the tank, supplied at intervals, to produce a permanent and more equalized counterbalance. The dimensions are as follows:—Gauge, 4 feet 8½ inches; cylinders, 9 inches diameter and 16-inch stroke; wheels, 2 feet 9 inches diameter, with Bessemer steel tyres. Heating surface of tubes, 242·5 square feet; and of fire-box, 32·5 square feet; total heating surface, 275 square feet; saddle tank capable of containing 250 gallons of water.

The injector is self-adjusting, on the principle patented by Mr. Sellers, of Philadelphia, U.S., with the self-closing overflow patented by Mr. James Gresham, of Manchester. The fixing is simple; the only pipes exposed are that from the tank to the injector and that from the overflow pipe. The steam pipe is conducted from the dome and screwed into a cast-iron flange to which the steam branch of the injector is attached, dispensing with a separate steam valve. The fire-box is furnished with Mr. D. K. Clark's smoke-burning apparatus. There are three openings arranged alternately on each side of the fire-box, and jets of steam may be blown into them, thus inducing a current of air on to the surface of the fire. The quantity of air is regulated by means of two plates with holes corresponding to those on fire-box, each plate sliding in guides screwed into the shell of fire-box. These plates are simultaneously drawn in opposite directions by means of a lever, and thus increase or diminish the openings for the passage of air without interfering with the steam jet. The engine is furnished with Adams and Parsons' slide valve, fully described in Vol. iii., Third Series, of this journal.



The results obtained from a model of the arrangement of valve motion were as follows; the suppression and release of the steam are given in percentages of the stroke of the piston:—

Forward Gear.

Front Stroke.			Back Stroke.	
Notch.	Suppression.	Release.	Suppression.	Release.
1	75½	90½	76	1½
3	53½	79½	53½	80
5 mid.	15	54	17½	55½

Backward Gear.

Front Stroke.			Back Stroke.	
Notch.	Suppression.	Release.	Suppression.	Release.
1	76½	91½	78	93¼
3	50¾	79	50½	2
5 mid.	13	44½	13	46

The axles, tyres, crank pins, connecting rods, coupling rods, piston rods, and valve rods, are of Bessemer steel.—V. D.

DYNAMITE.

Dynamite, from the Greek word *δυναμις*, "force," is the hitherto dangerous and prohibited nitro-glycerine robbed of its unsafe qualities; but the following experiments, which we ourselves witnessed, prove it to retain all those highly important properties of a most powerful and cheap explosive agent. These experiments took place on Monday, June 15, at Faill's Ladywell Quarry, Duke Street, Glasgow, before a large assemblage of scientific gentlemen. This new explosive was invented and is manufactured by Mr. Alfred Nobel, of Hamburg, and is in appearance somewhat similar to that of Barbadoes sugar. The following is a report of the experiments, which were most successful and interesting, besides being throughout complete in their character.

Experiment No. 1.—*Preliminary Trial.*—A couple of tablespoonsful placed on a very thick wooden beam proved sufficient to break it asunder, and to project one piece a considerable distance.

Experiment No. 2.—A wooden box, about 5 inches square, and full of dynamite, was thrown from the top of the quarry on to a heap of large stones, a height of between 50 and 60 feet, and by not exploding proved itself to be harmless by percussion alone.

Experiment No. 3.—A wooden box similar to that used in the former experiment was placed in a fire, and burnt harmlessly, emitting a shower of white ashes, thus proving itself safe by fire alone.

Experiment No. 4.—A loosely-packed cartridge, containing about one-third of an ounce of dynamite, was placed on a stone, with an ordinary fuse inserted, having upon the inserted end a powerful percussion cap. When the fire in the fuse reached the cap, the whole exploded with great violence, thereby proving that heat and percussion combined are required to explode it, and that separately used neither will explode it.

Experiment No. 5.—A charge of about 6 lbs. of dynamite was placed in the rock, 15 feet from the face and 15 feet from the top of the quarry, and fired, when it brought down about 4000 cubic feet of the rock, a hard and compact whinstone, and loosened twice or thrice as much more.

Experiment No. 6.—A charge of about 4 lbs. was placed in the solid rock, about 9 feet 6 inches from the surface, and fired, when it shattered the rock in the most successful manner, doing more execution than any possible charge of gunpowder under the circumstances could have done.

Experiment No. 7.—A cartridge, containing about 1 lb. of dynamite, with a fuse and cap inserted, was suspended from a cord extending across the quarry, and when fired gave a report that appeared startling, considering the small quantity of material exploded. This experiment was to prove the use of the substance for signals of distress at sea when a gun could not be fired; for many vessels carry no guns on account of their weight, and in those that do carry them it is not always possible to charge and fire them, but it is always possible to sling a cartridge, with a fuse attached, to the signal halyards or other part of the rigging; and they could be stowed away in a very small space with perfect safety, and be always ready for use.

Experiment No. 8.—A bar of malleable iron 6 inches in length and 1½ inches in diameter, accurately turned, was placed in a wooden cylinder, with one-half projecting outside, while the space between the inner half of the bar and the walls of the wooden cylinder was filled up with about ½ lb. of dynamite, which was then fired, when that half of the iron which was inclosed in the cylinder was found to be $\frac{1}{32}$ of an inch less in diameter than that half which projected beyond it. This experiment illustrates very strikingly not only the tremendous explosive force of the material, which is about twelve times more powerful than gunpowder, or three times greater than gun-cotton, but it pointed out also the peculiar local effect which it possesses; for whilst the explosive effects of other agents usually spend themselves in the direction of least resistance, this, most singularly, acts in a more decided way upon the objects nearest to it, whether situated in the direction of least resistance or not.

Experiment No. 9.—A cylindrical mass of best scrap malleable iron 12 inches in diameter and 10 inches long, having a hole 1⅛ inches in diameter extending almost its entire length, was split into four large fragments only by the small amount of dynamite which was required to fill that portion of the bore remaining after the ends had been closed by screw plugs between two and three inches long. The fractures of the iron presented an interesting sight, and conveyed from their large crystalline facets, some idea of the terrific and suddenly induced amount of force which the material possesses.

Experiment No. 10.—A solid cylindrical mass of malleable iron 9 inches in diameter and $8\frac{3}{4}$ inches in length, having 4 lbs. of dynamite placed on its top, was fixed firmly in the ground and covered with loose rubbish. The result of the explosion was to convert what had been a convex surface into a concave one, besides driving the mass 2 feet 6 inches in the ground, and at the same time to split the mass of iron in such a manner as a piece of clay appears when cracked from exposure to the sun. Its diameter at the surface of impact was increased to $9\frac{3}{4}$ inches.

Experiment No. 11.—A wooden cylinder of the same kind as that used in experiment No. 8 was charged with $\frac{1}{2}$ lb. of dynamite, and a tinplate placed before the mouth; this was placed about 20 inches from two boiler plates, each $\frac{3}{8}$ of an inch thick, and touching each other; the fuse was then lighted, and the effect of the explosion was to drive that portion of the tinplate which was opposite the centre of the cylinder through both of the plates, making a hole in each sufficiently large to admit one's finger. The thickness of the tinplate was about $\frac{1}{64}$ of an inch. The wooden cylinder in this case, as in experiment No. 8, was blown into tiny shreds having the appearance of particles of touchwood.

Experiment No. 12.—About $\frac{1}{4}$ lb. of dynamite was placed on a block of stone weighing from 3 to 4 tons, a fuse fitted with a cap was then placed in it, and the whole covered up with clay, and the effect of tho explosion was to crack the stone in such a manner that a few blows with a dressing hammer and chisel were only necessary to make it ready for the builder's hand.

Experiment No. 13.—A cartridge containing about 1 lb. of dynamite was placed in a hole in the rock 8 feet long, having water at the farther end; it was then fired, and the whole rock was much shaken; and though not falling, it was apparent that a very small charge would bring the whole down. A great deal of water was thrown with great violence out of the hole to the distance of about 20 yards.

This last experiment closed the proceedings, which, as before stated, were highly satisfactory, and fully proved the superiority of the material over gunpowder, in so far as both safety and explosive force are concerned. We should add, that the pieces of iron operated upon are lying at the office of Messrs. Downie & Co., Royal Bank Place, Glasgow. —N. W.

MERTENS' MACHINE FOR STRIPPING FLAX AND HEMP.

We illustrate a machine for stripping flax and hemp on M. Mertens' system, exhibited at the recent Paris Exhibition by M. Leurs, of Brussels. This machine obtained a prize medal at the French Exhibition of 1855, but has since undergone considerable improvement.

Fig. 1 shows a machine called a *double* machine. It is about nine metres in length. The flax or hemp, which should be very dry, is placed on a table, A, and is caught between two endless feeding surfaces, B, formed of transverse jointed laths, to which is imparted a rotatory motion round skeleton supporting frames, composed of iron rods and rollers. The flax thus laid hold of at one end passes into a box or receiver, wherein its free end is subjected to the action of two skeleton cylinders formed of discs carrying bars, and turning like the rolls of a rolling mill. The motion of these cylinders is at right angles to that of the endless feeding surfaces, their bars or plates being at right angles to the flax and in their rotation gearing with one another. The flax, being drawn by the endless surfaces at the same time that it is rubbed between the plates or bars of the two cylinders, becomes perfectly stripped and cleaned; and as it is capable of moving freely, it is not liable to get broken or have its fibres entangled, thus considerably diminishing the amount of waste in the subsequent combing operation. The flax as it proceeds from the first receiver is only stripped through half its length; it is then necessary to subject the other half which was held between the endless bands to the same operation. For this purpose, when the flax proceeds from the box at the point C, it is laid hold of by a strap, D, passing over two drums, disposed the one over the other, which causes it to move forward, so that the stripped end may be grasped by a second pair of endless feeding surfaces, F, situate in front of the former, from which the other end to be operated upon is conducted into another box similar to the first one, but turned the reverse way. When the flax proceeds from the second box it is perfectly stripped, both ends having been successively treated in the same manner. Two attendants are required for this machine—one to arrange the flax to be operated upon at one end, and the other to receive it when stripped at the other end. The quantity of flax operated upon is about 2000 kilogrammes per diem, corresponding to a produce of

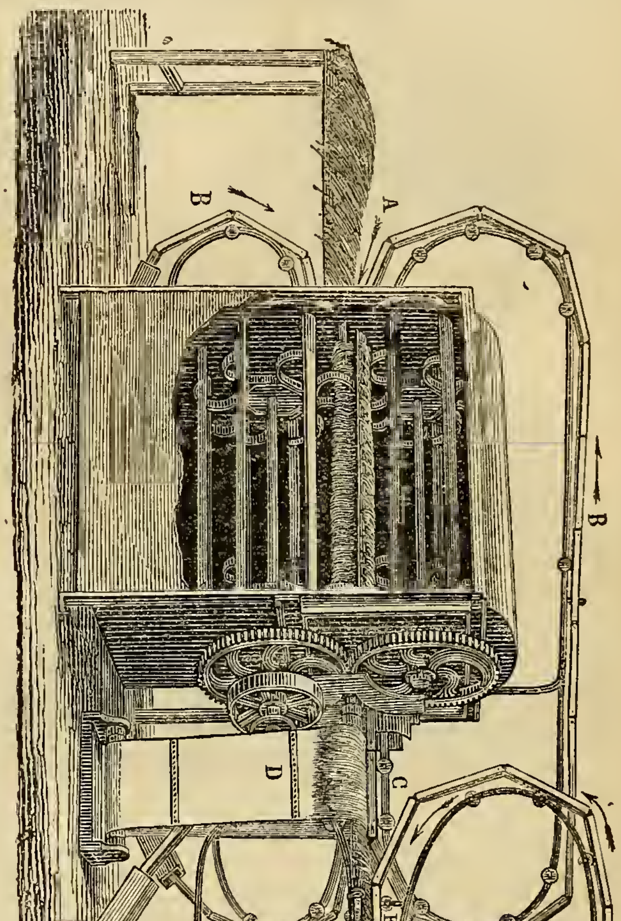
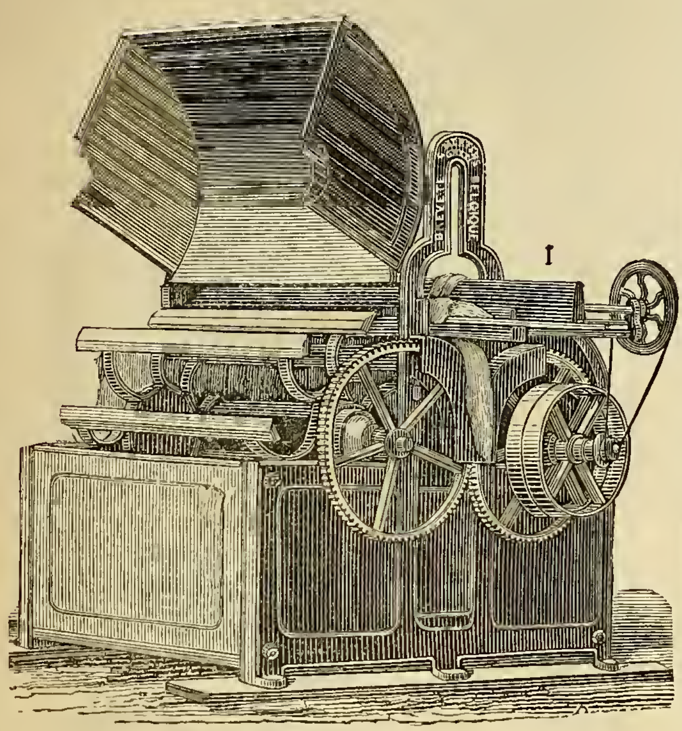


Fig. 1.

not less than 400 or 500 kilogrammes of flax in its stripped state. The quantity of hemp treated is about 3000 kilogrammes.

M. Leurs also supplies a smaller class of machines, or "*simple* machines," for use in smaller establishments, one of which is illustrated in fig. 2. In this there is but one series of cylinders instead of two; but the operation is the same in principle, only as the material proceeds from between the cylinders it is requisite to take hold of it and pass it through a second time in order to effect the stripping of both ends. The endless bands or feeding cloths are dispensed with, the cover is raised, and the flax is disposed in the machine on nippers, to which an advancing motion is imparted. The produce of the small machine is not more than one-half that of the large, and it requires four attendants, which may, however, be children. The stripping is effected automatically, the flax or hemp only requiring to be placed in the machine, and received as it proceeds from it in a perfectly stripped and cleaned condition.

Fig. 2.



THE MONT CENIS RAILWAY.

A traveller who crossed Mont Cenis on one of the trial trips shortly before this railway was open to the public has sent us a few notes on the subject. The project was formed, as is well known, for the purpose of connecting the lines of France and Italy, which had been previously interrupted by the chain of the Alps, by means of a temporary line until the wonderful tunnel through that chain is completed. St. Michel, the terminus of the old French railway, has a height of 2323 feet above the sea; Susa, the terminus of the Turin line, a height of 1690 feet; and the summit of the pass of 6890 feet. There is consequently an ascent from St. Michel of 4567 feet, and a descent to Susa of 5200 feet in the short space of 25 geographical miles in a straight line. The length of the new railway is only about 67 miles, and the gradients must therefore be of a very unusual character. In fact, they sometimes amount to one in eleven, a gradient that had seldom if ever been attempted in a railway. The Fell system, by which roads so steep as this are rendered traversable, consists, as most of our readers are aware, in having on the inclines a third rail placed exactly in the middle between the other two rails, and in so placing some pairs of horizontal wheels underneath the engine and the carriages that they grip the intermediate rail lightly, and hang, as it were, the engines and carriages on to it.

The route taken by the railway is for the most part in the immediate neighbourhood of the old diligence road, indeed they are usually side by side. Nevertheless rocks had to be removed in order to allow of the two to pass through the same opening, or tunnels had to be made. Not unfrequently, however, the inclination of the carriage road, or its angles at the turns, were a little too much for even Mr. Fell's line to face, and in such places, therefore, a new route had to be struck out for it, but the railway always rejoins its companion, the road, as soon as it can. The desirableness of keeping close to the carriage road for the purpose of saving expense, has led to the formation of a single line of small gauge, only 3 feet 7½ inches, and with very numerous curves of small radius. All the tunnels, some ten in number, are on curves, and some have even double or S curves. The extraordinary gradients involve the problem of building engines combining the maximum of power with the minimum of weight. They also involve the necessity of very light loads, and of frequent stoppages to take in fresh supplies of fuel and water. The small radii of the curves will prevent any but short trains being run, and the speed, from the narrowness of the gauge, must be slow, probably not more than 12 miles an hour. It must, we imagine, be not only an expensive line to maintain, but an expensive line to work, for to each carriage and to each engine are attached two men to work the brakes and horizontal wheel machinery. Besides this, as the line frequently crosses the diligence road, a man is needed at every crossing to elevate the central rail when the train approaches, and lower it when it has passed.

On the occasion when our correspondent travelled by the line, a single carriage and two wagons, loaded with fuel and sleepers, were attached to the engine, a weight of possibly 20 tons. The journey was perfectly successful, but there were nine stoppages for taking in water. The seats in the carriages are not placed across the carriage, but along each side, as in omnibuses. There is a door at each end, so that the guard can pass inside the train from one end to the other. The first-class carriages are made to hold twelve passengers; the second-class fourteen. On the upper part of each slope considerable lengths of the line are covered in with zinc, or other sheet metal, to keep off the snow, which, if it were allowed to accumulate, would entirely prevent the working of the trains. These covered passages, however, lead to a great inconvenience, for the smoke proceeding from the fuel is so offensive that the door in front of each carriage must be closed, and then the air of the interior becomes oppressively close. In winter, when the low temperature will oblige both doors to be closed, the closeness will be very much felt, for the windows are made not to open. Some alteration by which ventilation can be obtained is urgently needed.

SEWING MACHINE ACCESSORIES.

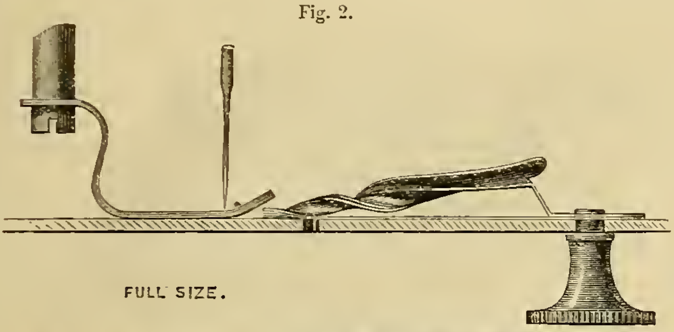
Although much has been written descriptive of the construction and operation, as well as of the rise and progress of the Sewing Machine *per se*, little or no notice has hitherto been taken of the various exceedingly useful and ingenious little accessories which form such important adjuncts to the sewing machine itself, and render it in fact the accomplished seamstress it now is. A sewing machine without its accessories may be compared to a carpenter whose only implements consist of a hammer and nails: it would certainly be capable of *uniting* materials together, but would have no power of manipulating these materials with a view to the production of the various descriptions of work required. But with the aid of special appliances, fitted on to the machine itself, not only may fabrics be stitched or united together, but the various operations known to the seamstress as Hemming, Felling, Tucking, Binding, Cording, Braiding, and Gathering may be readily accomplished. Each of the leading sewing-machine manufacturing establishments has its own peculiar contrivances for accomplishing some or all of the operations above mentioned, these accessories being specially adapted for use in the particular class of machine supplied.

It is our purpose, in a series of articles to appear from time to time in these pages, to illustrate and describe, in language as free from technicality as the subject will admit, the various sewing-machine accessories adapted to the different leading machines of the day, and the modes of applying and using them. As the Willcox & Gibb's machine is acknowledged to be of all the leading machines the most simple in its general construction, we will take the accessories of that machine first in order.

The operation which is most called into request by the seamstress is that known as *Hemming*. Probably most of our male readers even are aware that in hemming it is necessary first to turn or fold over the edge of the fabric to be hemmed; and that it is not sufficient to turn it over once only, but that in order to conceal the raw edge a second turn or fold must be given, as will be understood by the diagram (fig. 1) of a folded hem ready for sewing down. Now this operation of folding the hem by hand is not only tedious, but requires considerable practice to accomplish with regularity and precision; but by the sewing-machine hemmer the fold or hem is turned over with mathematical precision, and is simultaneously sewn down. In the Willcox & Gibb's machine two hemmers are employed, viz., the narrow and the wide hemmer.

Narrow Hemmer.—Figs. 2 and 3 represent respectively a side elevation and plan of the narrow hemmer, adjusted in its place on the cloth plate of the machine. It consists essentially of two tapering strips of thin steel, twisted together to the extent of one complete turn. These are mounted on what is called a check plate, provided with a projection at the front, which fits into a hole made for its reception in the cloth plate of the machine, just in front of the toe of the presser foot, as shown in the engravings, and thus insures the proper position of the hemmer. The rear end of the check plate carries a screw pin, which passes down through a corresponding hole in the cloth plate, and is secured by a thumb-nut below. The edge of the fabric to be hemmed is to be introduced between and drawn along the two spiral blades of the hemmer, which will have the effect of turning over the edge, as shown in fig. 1. The fabric should be drawn sufficiently far forward to project well over the feed surface. On lowering the presser foot and starting the machine, if care be taken to guide the fabric properly between the spiral blades, the folding and the stitching of the hem may be carried on simultaneously under the guiding finger of the operator at the rate of about 3 feet per minute.

Fig. 2.



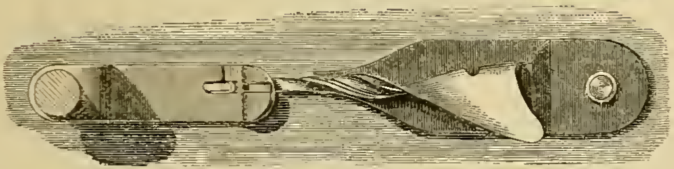


Fig. 3.

Fig. 1.

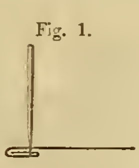
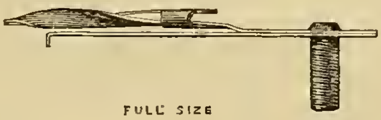


Fig. 4.



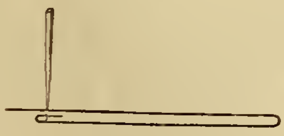


Fig. 6.

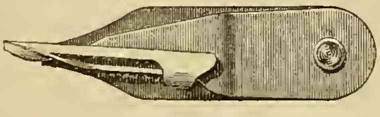


Fig. 5.

Wide Hemmer.—The wide hemmer, of which we give a detached side elevation and plan at figs. 4 and 5, is used, as its name implies, for making wide hems; that is to say, hems of a greater width than the ends of the blades in the narrow hemmer. The wide hemmer is intended only to impart a half turn to the edge of the fabric; that is to say, merely to fold over once the raw edge (see fig. 6), the greater or less width of the hem being obtained by previously folding down the same by hand according to requirement. As only a half turn is required by the wide hemmer, one of the blades may be straight as shown, whilst the other is twisted over it towards the extremity half a turn. Both hemmers are provided with precisely similar check plates, and fit into the same fixing holes in the cloth plate. The wide hemmer is also used in this machine for turning in the raw edge of the fabric where two pieces are to be felled together.

Binder.—The object of the binder is to adjust or apply bindings of various widths to the edges of fabrics as fast as the same are stitched or secured to the fabric by the stitching mechanism of the machine. Fig. 7 is a perspective view of the binder, showing its position on the cloth plate, in reference to the presser foot and needle when adjusted for work. The essential feature of this binder consists of two adjustable or sliding hooks, shown in edge view in fig. 8. These hooks are formed upon the edges of two sliding plates which are kept separated by an intermediate plate, to which they are connected at the edges, and which plate is also adjustable or capable of sliding between the hooked plates, a projecting pin being fitted into the intermediate plate for facilitating its adjustment. The binder is secured to the cloth plate by a thumb screw, which passes through elongated openings or slots in all three plates, and screws into a tapped hole in the cloth plate. The binding is inserted in a doubled or folded form thus ⊂ (see fig. 8) between the hooks and the grooved or <-shaped face or edge of the intermediate plate, and, of course, according as this binding is wide or narrow, so will the intermediate plate require to be adjusted from or towards the hooks. The two edges of the binding are engaged by the top and bottom hooks, which should always be so adjusted as regards the needle as that the stitches will be inserted well within the edge of the binding. The fabric to which the binding is to be secured has its edge passed between the two hooks (see fig. 8), and as fast as it passes under the needle the binding will be applied or turned over its upper and under edge, and be simultaneously secured thereon without any further manipulation on the part of the operator than properly guiding the binding material and fabric to be bound through the binder.

Fig. 7.

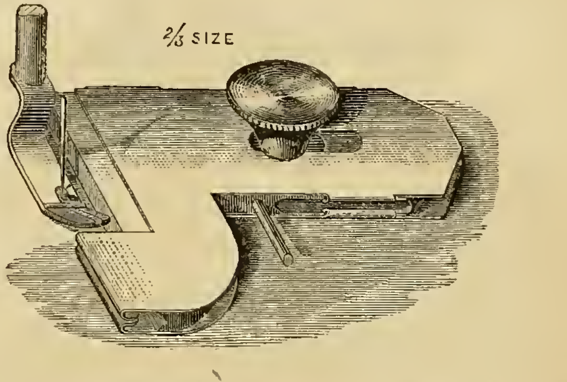
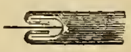
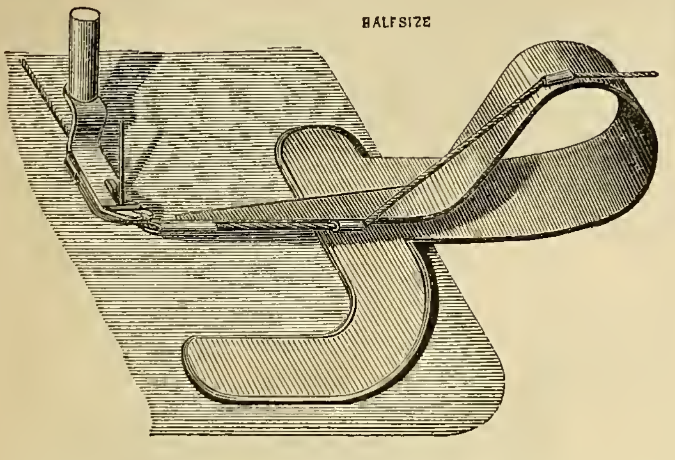


Fig. 8.



Corder.—The object of the corder is to introduce a cord within a longitudinally folded strip of fabric, and enable such folds to be stitched together alongside the cord as fast as the cord is laid in, thereby securing it in its place. Fig. 9 is a perspective view of the corder, showing its position on the cloth plate in relation to the needle and presser foot. The essential feature of the corder is a tubular guide, the end of which is bevelled slightly, and is situate just under the toe of the presser foot and in close proximity to the needle. Other tubular guides are situate on the curved arm of the corder for guiding the cord from a reel or bobbin, placed on any convenient part of the stand or machine. Sufficient clearance should be left under the curved arm of the corder to allow of the free passage of the fabric underneath it. The lower or flat portion of the corder is provided with set pins, which fit into corresponding holes in the cloth plate, and insure the instrument being always in its proper position as regards the needle and presser foot. When using the corder, it is requisite that the under surface of the presser foot be grooved or channelled longitudinally or in the direction of the feed, in order to receive the extra thickness produced by the cord, and to guide or direct the work in a straight course as it is fed forward. For this purpose a small movable shoe (shown in top plan view detached at fig. 10, and in under side plan at fig. 11, where the grooving of the under surface is also shown) is temporarily fitted on to the bottom of the presser foot, the shoe being provided with a small hook on the top in front and with side projections, as shown clearly in fig. 10, in order to enable it to be readily secured to the presser foot.

Fig. 9.



Self-sewer.—If it be required to sew at any given distance from the edge of the material, and parallel therewith, the attachment called the "self-sewer" will be found useful, more especially in the case of making tucks, as will be presently described, and when working on very light materials, such as calico or flannels. For heavy materials the ordinary guide or gauge which accompanies every machine will be found sufficient. Fig. 12 represents the self-sewer properly adjusted in its place on the cloth plate. It consists simply of an upper and under plate rivetted together at the rear end, so as to fit close against each other with a yielding or spring pressure; that portion of the lower plate which is opposite the needle when adjusted in position is provided with slightly inclined projecting ribs on the upper face, such ribs coinciding precisely with corresponding grooves made in the under surface of the same portion of the upper plate, the ribs and grooves fitting into or over each other. In lieu of being made parallel with the direction of the feed motion of the fabric which is introduced between the two plates, these ribs and grooves are directed at a slight angle therewith, in order that they shall have a tendency, as the fabric is drawn forward between them, to keep its edge well up to or against the guide pins, which are fitted into the lower plate and pass through holes in the upper one. The self-sewer is capable of adjustment nearer to or further from the needle in a lateral direction by having a slot made therein, through which the thumb-screw which secures it to the cloth plate passes, as will be clearly seen on referring to the woodcut.

Fig. 10.

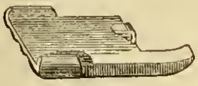
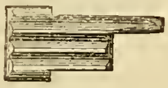


Fig. 11.



Self-acting Tuck Creaser or Marker.—In making a number of tucks in a sewing machine, it is a great convenience to have the fold of the next or succeeding tuck marked or creased simultaneously with the stitching of the tuck in hand; this is effectually accomplished by the tuck creaser, shown properly attached to the Willcox & Gibb's machine, ready for work, at fig. 13. The creaser consists of a bent steel blade, somewhat similar to a large pair of sugar tongs, the under limb of which is slotted, and is secured by a thumb-screw to a small bracket fixed into a hole in the stand or table of the machine by a thumb nut below the table. The object of this bracket is to bring the lower limb almost on a level with the cloth plate of the machine, upon the surface of which the end of the lower limb rests, as shown clearly in the woodcut. A small rounded projection or raised rib is made transversely across the upper surface of the lower limb at or near the end thereof, and this transverse rib or projection enters a corresponding slot or elongated aperture made in a curved or annular steel spring (shown more clearly in the end view of the tuck creaser at fig. 14), which spring is secured to the end of the upper limb, the inherent spring of the two limbs tending to maintain the projection constantly inside the slot referred to. A short strap is attached at one end to the end of the upper limb, whilst the opposite end of the strap is connected with a lateral arm or pin projecting from the side of a small metal cap or collar. This cap or collar is to be slipped on to the top of the needle bar or carrier, in order that, as the needle bar vibrates, it will lift slightly the free end of the upper limb of the tucker and allow it to descend again as the needle bar descends, by the inherent spring of the instrument. The tuck creaser is adjusted along its supporting bracket towards or from the needle according to the width of tuck to be made, and is then fixed by tightening the thumb screw. In combination with the tuck creaser the self-sewer described above should be used, adjusted so as to sew at a distance from the edge equal to the width of tuck required. The tuck creaser should be adjusted twice as far from the needle as the width of tuck desired, and as much farther as the desired distance between the tucks. Of course, it will be understood that this apparatus is not intended for very deep tucks. Having decided upon the width of tuck, say ¼ of an inch, the self-sewer is set to sew that distance from the edge, and the tuck creaser is adjusted ½ inch from the needle, plus the distance between the tucks, or say 1 inch. The main bulk of the work or fabric passes between the two limbs, or within the bow of the creaser, whilst that portion intended to be stitched is introduced between the

Fig. 12.

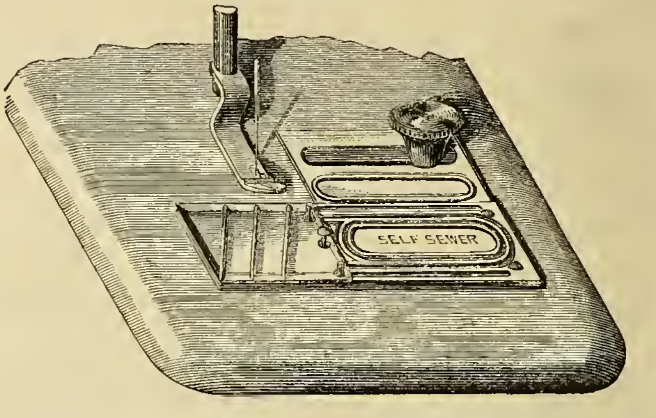
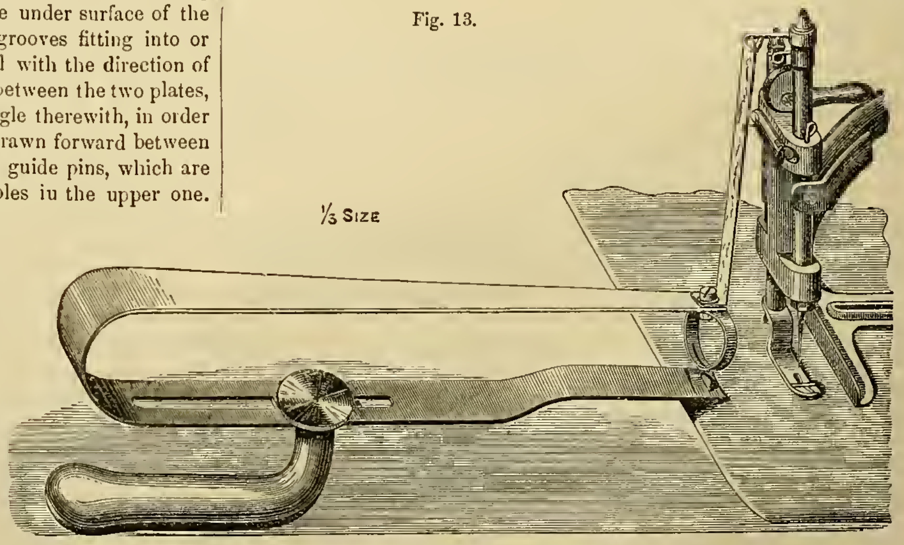
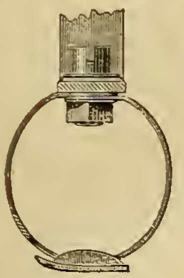


Fig. 13.



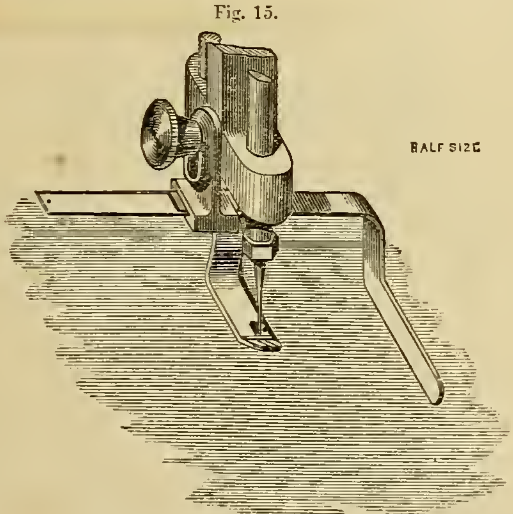
plates of the self-sewer and drawn forward under the needle. The portion of the fabric where the fold of the next tuck is to be made is passed between the projection and slot in the ends of the creaser limbs, the intervening portion of the fabric between the creaser and the needle being kept straight and flat. As the fabric is fed along, and the needle bar rises and falls, the annular spring on the end of the upper limb of the creaser will be alternately raised from the fabric and pressed on to it again; at each rise the fabric is free to be drawn forward stitch by stitch, but at each descent of the spring the combined action of the projecting rib and the slot form a sharp crease or score in the fabric, which being continued in a line parallel with the stitches, effectually marks out the fold for the next tuck. In commencing work it may occur that the first tuck is being marked whilst a broad hem is being made at the edge of the fabric by the aid of the wide hemmer above described, in which case the self-sewer is of course, for the time being, dispensed with.

Fig. 14.



Quilting Gauge.—In quilting or stitching a series of parallel, straight, intersecting lines upon fabrics, a quilting gauge is employed for insuring a uniform distance between the several lines of stitches. This gauge is represented as adjusted in its place at fig. 15. It consists simply of a steel bar capable of sliding through a dovetailed groove in a slotted holder, which is secured by a milled-beaded thumb-screw to the head of the fixed arm or bracket of the machine. The adjustable or sliding bar is bent downwards at one end, so as to bring it near to, but not in contact with, the cloth plate, sufficient clearance being left for the free passage of the thicknesses of material being quilted. The actual gauge portion of the instrument projects at right angles to the sliding part of the bar, so as to extend about an inch and a half along the last row of stitches introduced, and enables the operator, by keeping the last row always under the gauge, to produce the different rows at equal distances apart and perfectly parallel to each other. By sliding the gauge in or out, any desired width between the rows may be maintained.

Fig. 15.



Braider.—In the presser foot of the machine itself, shown in many of the woodcuts referred to in this article, a small rectangular-shaped groove or channel will be noticed in the upper surface of the toe or inclined end of the foot, and across the lower end of this groove or channel a small cross bar or bridge piece is represented, which is brazed to the surface of the presser foot. This bridge piece and groove serve to guide the braid in the operation of braiding, under the needle, the braid being first passed through the guiding groove and under the retaining cross bar or bridge piece, and finally drawn through the needle hole in the presser foot, and brought well under the needle. On working the machine, the braid will be stitched down on to the surface of the fabric, and by suitably guiding or manipulating the fabric as it is fed through the machine, various ornamental designs may be wrought out. There are other operations (such as "gathering" and "embroidering") capable of being performed in the machine itself by a dexterous operator; but as these do not of necessity call into requisition any special accessories, it would be out of our province to refer to them here. We may, however, refer our readers to the very clever adaptation made to the Willcox & Gibb's machine by Messrs. Arnold & Price, of the United States, for gathering fabrics and simultaneously stitching them to a plain band, and which was described and illustrated in an earlier number[*] of the *Practical Mechanic's Journal.*—E.P.A.

CAST-IRON BONE MILL.

(*Illustrated by Plate* 4.)

Mr. Edwin Pugh Baugh of Philadelphia has recently patented in this country some useful improvements in cast-iron mills suitable for grinding bones, ores, and other hard substances, which improvements form the subject of our Plate engraving this month. Mr. Baugh's improvements refer to that class of cast-iron grinding mills, the cutting and triturating surfaces of which are made in the form of a frustum of a cone. The shell and burr are constructed of a number of cast-iron grinding sections, fitted and held together in a peculiar manner, as described below, so that the sections can be readily removed to make way for others; the "dress" of the mill being thus rendered changeable to suit the substances to be ground, while the mill itself is more economical, both as regards its original construction and its lasting properties, and the variety of substances which it may be arranged to grind, than mills of the ordinary construction. The grinding sections of the shell are backed by an exterior casing between which and the base, to which the casing is secured, are confined the sections, so that the latter can be readily disconnected from the mill. The several sections of the burr are secured to a block between a lip or ring, or other projection, at or near the lower edge of the latter, and a ring fitted to the vertical shaft, which carries the burr so that the sections can be readily detached. The ring, which aids in securing the grinding sections of the burr, has grinding teeth formed thereon, and a breaker or stirrer is fitted to and turns with the vertical shaft of the mill; provision being made for rendering it easily detachable therefrom, so that different forms of breakers may be applied to the mill. Certain detachable sections are used, acting in conjunction with the breaker for preliminary grinding; these sections being fitted to and backed by a casing, and held in position by a cap-plate secured to the same, and carrying the bearing for the vertical shaft which carries the burr. The vertical shaft, with its burr and other appendages, are supported on a sliding step controlled by a lever and an adjustable weight, which tends to elevate the burr, but is limited in this tendency by a screw or other adjustable stop, the burr by this arrangement being maintained in the desired proximity to the shell, but being prevented from coming in contact therewith and injuring the grinding surfaces; the burr, at the same time, being at liberty to yield, should a piece of iron or other refractory material find its way between the grinding surfaces. In order to reduce friction and facilitate lubrication a double cone of steel is interposed between the bottom of the vertical shaft and the bottom of the step in which the shaft turns.

Fig. 1 of the Plate engraving is a half section and elevation of the improved mill; fig. 2 is a sectional plan of the upper portion of the mill; fig. 3 is a similar view of the lower portion; and figs. 4, 5, and 6 are details, which will be referred to hereafter. A is the base plate of the mill, secured to a foundation, B, and on this plate are fitted suitable bearings, *a a*, for the horizontal shaft, *c*, the latter being furnished at one end with a fly wheel, and between the bearings, *a a*, are fast and loose pulleys, *b b′*. At the opposite end there is a bevelled pinion, F, gearing into a bevel wheel, G, which is so secured to a vertical shaft, H, that both must turn together, while the shaft is at liberty to slide up and down through the boss of the wheel. This shaft has its lower bearing in a step, I, shown on a larger scale at fig. 6 in a casing, V, and which is secured to the base plate, A, as are also four columns, J J, which support the lower plate, K, of the mill and its superstructure.

To the vertical shaft, H, is secured the burr of the mill, which consists of the block, L, of cast iron and the detachable cast-iron grinding sections, *e*, the block being of the form, or approximating to the form, of the frustum of a cone, the sections conforming in shape to that of the block, and being secured thereto in the following manner:—Round the lower edge of the block there is a ring, *f*, and against the inside of the upper projecting portion of this ring bear the lower ends of the detachable cast-iron sections, *e*, the latter having at their upper ends lips or flanges bearing on the top of the block, and confined thereto by set screws or bolts, *h*. The form of each section is such, that one section will fit accurately against the adjacent section, the whole of the sections thus forming a continuous grinding surface.

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[*] See page 198, vol. v., Second Series.

The shell of the mill also consists of a number of cast-iron grinding sections, *i*, fitted together edge to edge, and backed by an outer casing, M, of the form or approximating to the form of a frustum of a cone, to which casing the sections are fitted, and by which they are held in place, the lower ends of the sections being confined between the flange, *j*, of the casing, M, and the flange, *k*, of the cast-iron ring, N, by bolts, *m*, which secure together the casing and the ring, the latter being confined to the plate, K, by bolts, *n*. In the present instance the case, M, is carried upwards in the form of an inverted frustum of a cone, and is lined with detachable cast-iron sections, *p*, which are held in place by the cap plate, P, secured to the top of the casing, M′, this plate having openings, *s s*, and a central boss, *q*, through which the shaft, H, passes, and in which it turns.

A stationary nut, Q, connected to the boss of the cap plate, P, receives a screw, R, the upper end of which is provided with a hand-wheel, S. It will be seen that the shaft, H, has a feather, *t*, adapted to a groove in the block, L, of the burr, and to a similar groove in the ring, *g*, of fig. 5, above which a sleeve, T, is fitted to and turns with the shaft, as it has a groove to receive the feather. To the sleeve is fitted what may be termed the breaker (fig. 4), which consists of a boss, U, having one or more projections, *u*, the sleeve having grooves adapted to keys or feathers in the boss of the breaker (see fig. 2). Both the breaker, U, and the sleeve, T, as well as the ring, *g*, and the burr, are confined by a nut, *v*, adapted to screw threads on the vertical shaft, H.

The foot-step bearing, I, previously alluded to, consists of a cast-iron box, arranged to slide in the cylindrical casing, V, secured to the base plate, A, and is furnished with a steel bush, *w*, in which turns the lower end, *x*, of the vertical shaft, H. Between the bottom of the shaft and the bottom of the bush intervenes a double cone, *x*′, of hardened steel, made somewhat less in diameter than the shaft, as shown clearly in fig. 6.

A lever, W, passing through a slot in the casing, V, is hinged at one end to a pin on a stud, *y*, secured to the casing, and bears against the underside of the step, I, the lever being connected at its opposite end by a link, X, to a lever, X′, which is arranged for receiving a movable weight, and is hinged to a bracket, Y, secured to the plate, K, a set screw, 2, adapted to a nut on a stand, 3, secured to the base plate, A, serving to limit the upward movement of the lever, X′.

Prior to setting the mill in motion, the lever, X′, is so weighted as to more than balance the vertical shaft, H, with its burr and breaker, so that the said shaft may have an upward tendency, which, however, is limited by the set screw, 2, the latter determining the distance apart of the grinding surfaces of the shell and burr. By this arrangement the grinding surfaces are maintained in sufficient proximity to each other to act properly on the material to be ground, but will not come in contact with each other; at the same time, should a piece of iron or steel find its way between the grinding surfaces, the burr and shaft will yield and prevent injury to the mill.

The shaft, H, and its burr and breaker having been caused to revolve in the direction of the arrow, the bones, quartz, or other material to be ground, are passed through the openings, *s s*, in the cap plate, P, to the conical space bounded by the detachable sections, *p*. Here by the combined action of the teeth or dress on these sections, and the revolving breaker, U, the material is fractured and reduced to comparatively small fragments when it has reached the ring, *g*; by the combined action of the teeth on the periphery of which ring and those near the lower portions of the sections, *p*, the material is reduced to a condition which permits it to enter the space between the grinding sections, *e*, of the burr and those of the shell. As this space becomes gradually narrower towards the lower end of the shell and burr, the material becomes gradually reduced, and finally leaves the grinding surfaces in the desired pulverized condition, and falls into the space within the ring, N, on to the slightly concave surface of the plate, K, where it is acted on by the revolving sweep, 4, the latter causing the discharge of the ground material through a spout, 5, into any suitable receptacle.

By making the grinding surfaces in sections, not only can both shell and burr be made truly round, but the teeth can be made of the most irregular character; for instance, the teeth or dress can be formed by grooves crossing each other, or some of the grooves may be straight, some curved, others diagonal, according to the nature of the material to be operated on. An indefinite number of changes may be made in the character of the dress when this mode of constructing the grinding surfaces of conical mills is employed, an important advantage, as the "dress" must be made to suit different materials, and in many cases different qualities of the same material to be ground; a dress for grinding bones, for instance, would be unsuitable in some respects for grinding quartz; and in operating on other substances it may be advisable for the dress of one section to differ from that of another in the same mill. It will thus be seen that the character of the mill may be entirely changed by a simple and speedy change of sections, and that when the teeth of one or more sections have become worn, broken, or otherwise inoperative, their removal, and the introduction of new sections, renews the mill, whereas an ordinary cast-iron mill would, under similar circumstances, have to be discarded. Bessemer steel would form a good material from which to cast the sections.

In removing the grinding sections, the screw, R, plays an important part; for should it be desired to remove the sections, *i*, of the shell and the sections, *e*, of the burr, all that is necessary is to first detach the nuts of the bolts, *m*, loosen the nuts of the bolts, *n*, and the nut, *v*, and then operate the wheel, S, so as to cause the end of the screw, R, to bear on the top of the vertical shaft, H, and continue to turn the screw until the entire shell of the mill is elevated so far as to permit the withdrawal of the sections of the burr and shell and the introduction of others, after which the shell is lowered by turning the screw in a contrary direction, the nuts of the bolts, *m*, replaced, and the nuts of the bolts, *n*, as well as the nuts, *v*, tightened.

Should it be necessary to remove the sections, *p*, only, the nuts are detached from the bolts which confine the cap plate, P, and the latter is elevated above the mill by operating the screw, R, when the sections are at liberty. After elevating the cap plate clear of the shaft, the nut, *v*, breaker, *u*, and ring, *g*, may be readily removed.

It has been found, after repeated experiments, that the double cone, *x*′, of steel performs most efficiently the duty of distributing to the lower bearing the oil contained in the space between the bottom of the shaft and the bottom of the step, I, at the same time preventing undue friction at the point subjected to the greatest shocks and strains. This mode of interposing the double cone between the bottom of the shaft and the bottom of the step may be applied to the lower bearings of all vertical shafts, to the pivots of swing bridges and turntables, and other objects having a vertical bearing to which great strains are subjected.

For grinding some materials it is not essential that there should be a superstructure, M′, and detachable sections, *p*, or a breaker above the shell, M, a simple hopper being in many cases all that is necessary to receive the material and direct it to the grinding surfaces; the latter, too, may (for grinding some materials) be straight instead of curved. It is preferable in most cases, however, to form teeth on the periphery of the ring, *g*, as shown at fig. 5, so that it may serve the twofold purpose of aiding in the preliminary or first grinding, and of keeping the sections, *e*, of the burr in place. The lips of these sections, *e*, may, moreover, be dispensed with, the ring, *g*, bearing directly on the upper edges of these sections. The casing, M, too, may be made in sections, or the grinding sections may be backed or held together by a suitable system of metal bands.

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RECENT PATENTS.

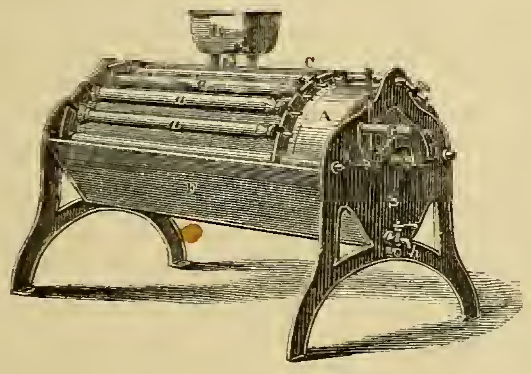
WASHING PRINTERS' ROLLERS.

Thomas Muir, *Glasgow.—Patent dated 21st September*, 1867.

This invention, which relates to an improved mode of washing the rollers and blankets used by letterpress printers, consists as follows:—The rollers to be washed are placed with their journals resting in brackets projecting upwards from a trough; in the trough a large revolving can or drum is placed, the can or drum being covered with blanket. The rollers to be washed are so disposed that when placed in the brackets their surfaces rest or lean upon the flannel-covered surface of the large revolving can or drum, and when the latter is revolved its frictional contact with the printing rollers causes them also to revolve. Across the top of the washing machine a perforated pipe extends, and it is connected at the centre, or thereabouts, with a vessel or reservoir containing the washing fluid, which, as the machine is in action, drops through the perforations on to the rollers, and then, being rubbed by the action of the blanket on their surfaces during the time that the washing liquid is falling, causes the ink and other matter adhering to them to be removed. The washing is finished by running pure clean water over the rollers after the washing liquid has been used. In connection with this invention it is preferred to use any one or more of the ordinary printers' washes at present in use.

In using this apparatus for washing printers' blankets, the blankets are placed within the large revolving drum, some parts of which are perforated, so that the liquid contained in the trough may pass through; and the interior of the drum being fluted, or corrugated, or formed with bars, the rubbing action produced by these surfaces and wooden balls placed therein as the drum is revolved, causes the ink and dirt to be washed out.

The engraving is a perspective view of a roller and blanket washing machine constructed according to this invention, and arranged that it may be driven by hand labour. The machine consists of a drum, A, constructed by preference of wood, and built up in staves on cast iron or other ends. In order to provide a soft surface for washing the printing rollers, *a*, the drum, A, is covered with blanket, which is again covered with "Macintosh" cloth or other suitable material. A transverse motion is given to the drum, A, by cutting the boss, *b*, which is formed on each end of the drum at a suitable angle, in different directions, which act against pins fixed in the standards, S. B is the can for holding the "lye," which is conveyed to the rollers, *a*, through the perforated pipe, C. After the ink on the printing rollers has been thoroughly softened by the application of lye, and the transverse rubbing motion of the revolving cylinder, A, a stream of water is admitted to the pipe, D, and ejected through perforations in the pipe for the purpose of washing the ink from the drum. To effect this more quickly a rubber or scraper is provided, which consists of a light bar of T iron, to the rib of which there is attached a strip of vulcanized india rubber. To each end of the box, *c*, a lever, *d*, is attached, which is carried upon a rod, *e*. The scraper is prevented from coming into contact with the drum, A, by holding the lever, *f*, in a suitable catch; but when rollers are being washed the lever, *f*, is released from the catch, the india rubber spring pulls back the lever, *f*, and the scraper, *c*, is pressed against the surface of the drum, A, which prevents the water from being carried round by, and also dries the surface of, the drum.



The waste water and lye is caught in the trough, F, which is provided with a cock, *h*, to run off the water, or the lye may be saved for future use by fitting a watertight division in the bottom of the trough, F; the rod, *e*, is fitted in the centre, at the bottom of the trough, F, and a scraper fitted in each compartment, so that the water is caught in one compartment and the lye in the other. *i i* are brackets in which the rollers, *a*, which are to be washed are carried. The "thin" printing rollers are preferred to be washed on the top of the drum, A, whilst the "thick" rollers are placed at the side, S. The brackets are supported on bars, and may be shifted to suit any length of rollers which are to be cleaned. The machine may be driven by the handle, G, or with other motive power, by means of a belt passing over pulleys, the centre pulley being fast and the two side pulleys loose, one of which is driven with an open belt, and the other with a cross belt, to give a reverse motion when washing blankets. The blanket washing is effected inside the drum, A; the blankets are put into the drum through doors, and by means of flutes, formed on the inner surface of the drum, and a number of wooden balls which are put in, the blankets are effectually cleaned by revolving the drum in alternately reverse directions.

REAPING MACHINES.

THOMAS WARDLAW, *Dunfermline.—Patent dated 19th Nov.*, 1866.

THIS invention relates to a peculiar construction, arrangement, and mode of operating self-acting side delivery rakes for reaping machines, and consists of an upright fixed standard secured to the main framing at the inner end of the cutting edge of the platform, such standard supporting a vertical rocking shaft which works in a footstep at the lower end, and in a bearing near the upper end of the standard. A rocking or partial rotatory motion to and fro is imparted to the vertical shaft by means of a horizontal arm secured to the lower end thereof, and jointed to the end of a connecting rod working from a crank shaft. The upper end of the vertical rocking shaft carries a horizontal cross shaft, to the longer overhanging portion of which the arm or arms of the rake is or are attached, whilst to the opposite end of such cross shaft, which also projects or overhangs slightly beyond the vertical rocking shaft, there is fitted a pinion, which bears against the under side of and gears with a horizontal toothed quadrant fixed by suitable brackets to the top of the upright standard; this pinion is connected to the cross shaft through the intervention of a ratchet wheel and detent, which will allow it to revolve loosely on the shaft when travelling along the quadrant in one direction, but will couple it with the same shaft when travelling in the opposite direction. The rake may be balanced on the cross shaft by securing a weighted balance lever to the opposite side of such shaft, or a second rake may be applied so as to balance the first, in which case no balance weight would be required, and the rakes would only have to travel at half the speed they would require if only one rake were employed. On imparting, say, a quarter of a revolution to the vertical rocking shaft (supposing the rake to be at the cutting edge of the platform), the cross shaft with the rake attached will be caused to sweep round horizontally over a quarter of a circle, thereby causing the rake with the cut corn to travel along the platform from the cutting edge thereof to the delivery edge at right angles thereto; whilst it is making this sweep the pinion turns loosely on the cross shaft, which latter consequently does not revolve on its axis, but on the return of the crank the cross shaft will move back again, so as to return to its former position over the cutting edge of the platform, and will, whilst so returning, revolve on its axis, as the pinion by the action of the ratchet and detent will then be coupled with the shaft. The rake will consequently turn over or make one revolution so as to be clear of the platform during the return sweep of the cross shaft, and be brought parallel to the knives in readiness for the next sheaf which is delivered, as before described, and so on. The rake is kept stationary by a stop or keeper at the top of the vertical rocking shaft until its next movement is required. If preferred the quadrant rack may be fastened to the foot of the upright standard, in which case the motion of the pinion may be transmitted by a pitch chain to the rake shaft. In some cases an upright spring may be fixed on the vertical standard, and a short lever arm carried by the top of the rake, such lever arm coming in contact with the spring and preventing the rake from revolving too far before it takes its horizontal sweep.

Fig. 1 of the engravings represents a front elevation, partly in section, of the self-acting side delivery rake for reaping machines, and fig. 2 is a plan of the same.

A is an upright fixed standard secured to the main framing, B, of the machine at the inner end of the cutting edge of the platform, C; this standard may be situate either on the outside of the framing of the machine, so that the mechanism for actuating the rake will work across the top of the driving wheels, or it may be situate inside the framing if preferred. This standard supports a vertical rocking shaft, D, which works on a footstep at the lower end and in a bearing near the upper end of the standard, or, if preferred, in two bearings, E, E^1, attached to the standard, as shown in the drawing; F is an adjustable collar and set screw for varying the height of the rocking shaft, D; a rocking or partial rotatory reciprocating motion on its longitudinal axis is imparted to the vertical shaft, D, by means of a horizontal arm or lever, G, secured to the lower end thereof, and jointed to the end of a connecting rod worked from the crank shaft of the machine. The upper end of the vertical rocking shaft carries a horizontal cross shaft, H, working in the two bearings, I I, in the cross head, J. To one of the overhanging portions or ends of this shaft the arm or arms, K, of the rake, L, is or are attached; whilst to the opposite end of such cross shaft, H, which also projects or overhangs beyond the vertical rocking shaft, D, there is fitted a slightly bevelled pinion, M, which bears against the under side of and gears with a horizontal toothed quadrant, N, fixed by arms, O, O, to the top of the upright standard; or the pinion, M, may work in rack teeth on the upper surface of the quadrant rack, if it be situate on the opposite end of the shaft, H, next to the rake. This pinion is connected to the cross shaft through the intervention of a ratchet wheel, *a*, and detent, *b*, carried by the cup, *c*, which will allow it to revolve loosely on the cross shaft when travelling along the quadrant in one direction, but will couple it with the same shaft when travelling in the opposite direction, the cup, *c*, being at all times fast on the cross shaft, H. The rake may be balanced on the cross shaft by securing a weight or a balance lever, P, to the opposite side of such shaft, or a second rake may be applied so as to balance the first; in which case no balance weight would be required, and the rakes would only have to travel at half the speed they would require if only one rake were employed. On imparting, say, a quarter of a revolution to the vertical rocking shaft, D, supposing the rake to be at the cutting edge of the platform, the cross shaft, H, with the rake, L, attached will be caused to sweep round horizontally over a quarter of a circle, thereby causing the rake with the cut corn to travel along the platform from the cutting edge thereof to the delivery edge, at right angles thereto. Whilst it is making this sweep the pinion, M, turns loosely on the cross shaft, which latter consequently does not revolve on its axis, but on the return of the crank the cross shaft will move back again, so as to return to its former position over the cutting edge of the platform, and will, whilst so returning, revolve on its axis, as the pinion, by the action of the ratchet and detent, will then be coupled with the shaft. The rake will consequently turn over or make one revolution in a vertical plane, so as to be clear of the platform during the return sweep of the cross shaft, and be brought parallel to the knives in readiness for the next sheaf which is delivered, as before described, and so on. The rake is kept in position during the delivery of the corn by suitable stops or keepers, which are arranged in the following manner:—A small round collar, *d*, is fitted on the cross shaft, H, close to the bearing, I, of the cross head, J, next the rake, and this collar has one or two notches made therein (according as one or two rakes may be employed). To the cross head there is fitted a catch, *e*, which engages into the notch when the rake is in the position for sweeping horizontally over the platform, and consequently the rake is maintained steady in its proper position during such movement. A finger or arm is attached to the catch, and slides along a light guide, *f*, fixed to the upper end of the fixed standard, A, such guide being inclined so that as the finger slides over it the catch will be elevated, and by the time the rake has completed its horizontal course the catch will be released from the notch in the collar, and will allow the shaft, H, and rake to turn over when the upright shaft makes its reverse movement, thus bringing the rake back to the cutting edge, where it is again locked, as before, and makes its horizontal sweep over the platform. If preferred, the quadrant rack may be fastened to the foot of the upright standard, in which case the motion of the pinion may be transmitted by a pitch chain to the shaft carrying the rake.

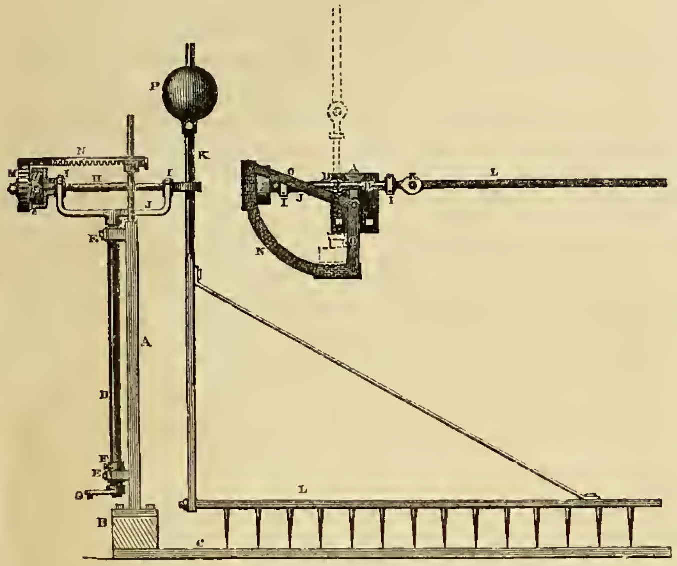


Fig. 2.

Fig. 1.

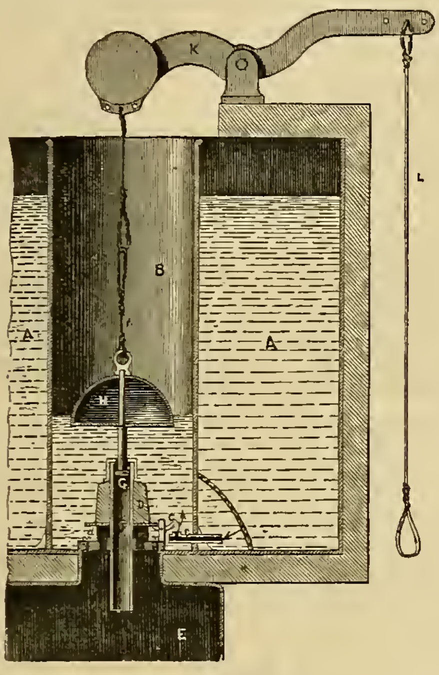
In some cases an upright spring may be fixed on the vertical standard and a short lever arm carried by the top of the rake, such lever coming in contact with the spring and preventing the rake from revolving too far before it takes its horizontal sweep.

PREVENTING WASTE OF WATER IN CISTERNS.

MESSRS. MACKENZIE AND ROBINSON, *Dublin.—Patent dated* 21st *September*, 1867.

THIS invention relates to a peculiar arrangement of apparatus applicable either to new or to existing cisterns employed for water closets, or other purposes, whereby waste of water is prevented, whilst, at the same time, a sufficient supply is afforded for effecting a flushing action if required. In applying the invention to water-closet cisterns, for example, a gauge chamber of sufficient capacity is constructed inside the cistern at the lowest part thereof, to contain the requisite amount of water for one flushing of the closet. A small aperture is made in the side of this chamber at the bottom for the purpose of filling the same from the surrounding water in the cistern, such aperture being opened by the act of closing the principal valve of the cistern when such valve is opened, a small inlet valve being employed for that purpose, adapted to the aperture referred to. At the bottom of the gauge chamber there is fitted the valve seat and valve, opening either into the old service box or into a supply pipe leading direct to the basin. This valve is provided with a tubular spindle, having a piston working therein, such piston being connected to a float inside the closed chamber before referred to, and on the lower part of the piston is formed a valve cap, and on the upper part of the tubular spindle, through which the piston works, there is formed a valve seat, so that when the piston is raised by the float to a given height the second passage for water (namely, the passage through the tubular spindle) is closed, and remains closed until by the opening of the principal valve the chamber is emptied. This piston is further coupled by a wire to the usual overhead weighted lever, which is connected to the "pull," or handle of the closet. The object of the entire arrangement is, first, to admit the full complement of water in the closed chamber to pass down through the principal valve when opened, and, secondly, to permit of a certain gauged or regulated quantity of water, sufficient to fill the pan of the closet, to descend through the tubular spindle of the main valve after it has been closed. This latter is the result of the quantity of water admitted to flow through the small open aperture, being in a certain proportion in excess of the quantity which can pass down through the tubular spindle or piston valve, and, consequently, the chamber will in a short time become nearly full, and the float raised so as to close the inner valve. This float, however, is not sufficiently buoyant to open the principal valve.

The engraving represents a sectional elevation of the improved apparatus for preventing waste of water. A represents a water cistern of the usual or any other construction, in the interior of which, at its deepest part, is formed the gauge chamber, B, which has no communication whatever with the surrounding water in the cistern, A, excepting through the lateral valvular orifice, C, near the bottom of the said gauge chamber. This orifice is opened and closed by the lever valve, C, the tail of which is caused to project underneath the bottom of the main flushing valve, D, of the closet (supposing the apparatus to be applied to a water closet), so that when that valve is down upon its seat, *d*, or closed, it will, by depressing the tail of the lever valve, keep the said valve, c, open, as shown, and allow free access for the water into the interior of the gauge chamber, B, the water gradually rising therein until it attains the level of that in the main part of the cistern, A. The gauge chamber will then contain just sufficient amount of water to effect the proper flushing of the closet. When the "pull" of the closet is raised the valve, D, will be opened, and the water in the chamber, B, will be rapidly discharged, either into the ordinary service box, E, or direct into the pipe leading to the closet, without the intervention of the service box. F is a tube passing through the main valve and forming the stem or spindle thereof. On the upper end of this tube there is screwed a metal seat, *f*, which projects inwards round the interior of the tube, and forms a valve seat for the leather packing, *g*, of the piston, G, to close against when elevated. This piston fits the bore of the tube with sufficient freedom to allow of the passage of water between the piston and the interior of the tube; the rod, *h*, of the piston also having a sufficient clearance round it to afford egress for the water down the tube when the piston is in the position indicated. H is a float attached to the piston or valve rod, *h*; it should have just sufficient buoyancy to raise the piston, G, or valve, G′, and thereby close the thoroughfare of the tube, F, but not to elevate the main valve, D; to the top of the piston rod is attached the wire coupling, I, which serves to connect the valve with the ordinary weighted lever, K, to which the "pull" of the closet is connected by the usual wire or other connection, L. When the water is discharged from the gauge chamber, B, the float, H, descends by its own gravity, opening the passage through the tube, F, and this passage remains open after the main valve has been closed until the water which again enters the chamber by the valvular inlet orifice, C, has risen sufficiently high to buoy up the float, and thereby lift the piston and close the passage through the tubular valve stem. In the meantime the water, which enters more quickly by the inlet, C, than it can escape by the tube, F, has been simultaneously flowing down through the top of the said tube of the closet, and the respective areas of the inlet orifice and the escape orifice of the tube, F, are so regulated as to allow sufficient water to flow into the closet to replenish the basin or pan before the rising of the float completely stops the supply. The chamber, B, thus continues to fill till the water therein finds its own level, when the apparatus will be ready for use again. It will thus be evident that for flushing the closet the contents of the chamber, B, only can be discharged at one time, however long the "pull" may be kept elevated, and that after it is released again no more water will enter the closet than is absolutely necessary to replenish the copper pan at the bottom.

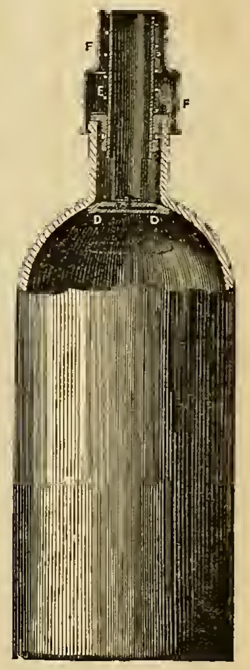


STOPPERS FOR BOTTLES.

Messrs. Prudencio, Cooper, and Cotterell, *Bath.—Patent dated 18th October*, 1867.

This invention relates to that class of stoppers, for bottles and other like receptacles, which are self-closing, and in which the valve or stopper itself is contained inside the bottle or other receptacle. The same arrangement may be used as a self-acting cock for casks and similar vessels. According to this invention, a self-closing stopper is constructed which does not necessitate any special form of neck, but may be applied to ordinary bottles. The improved stopper consists of a tube of metal, which is free to slide through a metal or other collar, which rests on the top of the neck of the bottle or end of the cock; an india rubber or other packing ring serving to keep the tube in a central position, as well as to prevent any leakage at that part. The inner end of this sliding tube carries a disc valve of india rubber, which closes against the inner shoulder of the neck of the bottle, or against the inside of the aperture in the case of a cock. A helical spring surrounding the outer portion of the tube, and confined between the collar and a cap or dome on the extreme outer end of the sliding tube, serves, in conjunction with the internal pressure, to keep the valve perfectly tight. When it is required to draw off the contents of the bottle or vessel, it is simply necessary to depress or force inwards the dome or cap, whereupon the valve is opened and the liquid passes through the tube, and is discharged at the outer end thereof.

The engraving represents a side elevation and part section of the self-closing stopper, as applied to a bottle. A is a tube of metal or other suitable material capable of sliding freely in a metal or other collar or washer, B, which rests upon the india rubber packing ring, C, fitting inside the neck of the bottle, and serving as a guide for keeping the tube, A, central. To the lower or inner end of the tube, A, there is secured a disc valve, D, of india rubber or other suitable material. This valve is so constructed as to admit of it being inserted with comparative ease into the bottle neck, whilst it offers considerable resistance to its withdrawal again. To obtain this result the valve is provided with an internal stiffening disc, *a*, of metal or other stout material, which should be so embedded in the india rubber of the valve as to leave a greater thickness of the india rubber above the disc than below it. E is a helical spring which surrounds the tube, A, and tends to keep it elevated by pressing against the underside of the cap or dome, F, which is fixed on to the upper end of the tube, and incloses or surrounds the outside of the neck of the bottle. This cap may be more or less ornamented, and may be composed of metal, hard india rubber, or any other suitable material. In order to discharge the contents of the bottle it is simply necessary to depress the cap or dome, F, when the spring, E, will be compressed, and the tube, A, and valve, D, lowered, the liquid being then free to escape through the tube, A. On releasing the cap, F, the valve will instantly close upon the inner shoulder or orifice of the bottle neck, and preserve the remainder of the liquid in the bottle, if there be any left, perfectly air-tight.



SPINNING MACHINERY.

James Eaton, *Boston, U.S.A.—Patent dated 24th October*, 1867.

This invention has reference to improvements in the bearings of the spindles of mules and other spinning machinery, and also to an improved system or mode of and means for lubricating the journals of such spindles. The main feature of the invention consists, firstly, in the application of oil or other lubricating liquid to the bolster and the step of spindles, by means of a saturated fibrous substance, in such a manner as to prevent the waste of the oil and confine its action to the bearings; second, in the form of a bolster, which is so made as to allow the spindles to be removed with great facility; third, in the mode of affixing the bolster, and adjusting it in the line of the axis of the spindle; fourth, in the shape or contour of the bearings, to conform to the direction of the driving band; fifth, in the substitution of a long bearing for the bottom of the spindle in place of the common shallow cup or step, for the purpose of securing a more steady motion and reducing the wear of the spindles, especially of those that are driven from the bottom of the upright drum in mules, and have the driving wheels near the bottom of the spindle.

Fig. 1.

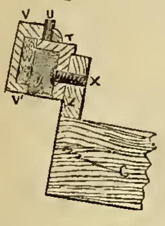


Fig. 2.

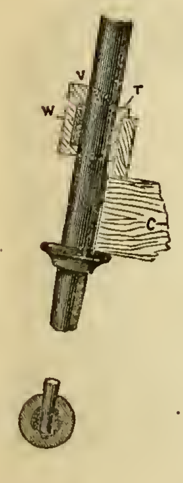
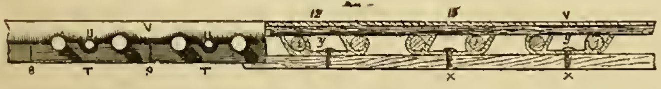


Fig. 1 is a section of bolster and lubricator; fig. 2, a section of bolster and lubricator, with one spindle in place; fig. 3, a top view and horizontal section of the bolster and lubricator; fig. 4, the tubular step. The step that supports the base of the spindle may be tubular, as represented in fig. 4. In this mode the brass tube, L, rests in a long groove made in the base block, and has at its upper edge a series of holes, N N, through which the lower ends of the spindle, I I′, are inserted, their ends resting on the inside wall of the tube. Within the tube, L, there is a band or cord, O, of felt, or other fibrous substance, saturated with oil. The ends of the tube may have an upright tube attached to receive the oil which is absorbed by the fibrous stuffing of the tube, or a screw cap may be applied at the ends of the tube, and the oil introduced at the spindle apertures, N. By this simple arrangement a permanent bearing is secured of suitable material, protected from dust, having the lubricant always in contact with the spindle, and preventing the evaporation of the oil. When the fibre, O, is well saturated with oil, it will last several weeks without renewal. This tubular step or bearing may be of the length of one "door"—say from twenty to forty spindles, or it may be in shorter lengths if deemed desirable. The lubricating bolster forming the upper bearing of the spindle is constructed as follows:—The horizontal back piece, Z, fig. 1, is fastened to the end, C′, of the framework, and supports the short bolster or bearing piece, T, by means of the screw, X, the head of the screw being in the open space, G, between the bearings. By adjustment of the screw, X, the bearings may be made to occupy their proper position with reference to the spindles and the step. On the top of the bolster, just above the screw, there is a pin, U, which serves for the attachment of the movable lubricator, V V′, which is provided with a corresponding hole. This lubricator is in the form of a box, having the side next to the spindles open to allow of the contact of the felt or cloth, W, contained in the inside of the box. The lower edge, V′, of the box is wide enough to support the strip of cloth, W; its edge rests against the frame, its sole support being the pin, U. By the use of this improved step the wear of the spindles and steps is prevented, and less power is required to drive the machine. To remove the spindles it is only necessary to lift the lubricating box, V, from the pin, U, the box being made of any length most convenient for this purpose. In the horizontal section, fig. 3, it will be noticed that the bearings differ in shape; this form is such as to insure the contact of one-half of the spindle with a semicircular bearing which fits it with accuracy.

Fig. 3.



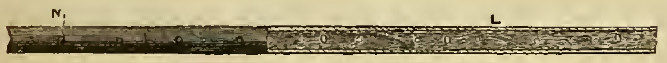


Fig. 4.

RAILWAY WHEELS.

Cornelius Kingsland, *of M'Keetport, U.S.A.—Patent dated 28th September*, 1867.

This invention relates to the manufacture of "chilled" railway wheels, and has for its object the avoiding the danger of fracture arising from the great strain or tension in the metal, produced by the cooling of the periphery of the wheel after casting. According to this invention it is proposed to cut away or remove a portion of the "chill" under the flange of the wheel, so that in moulding or casting the outer part of the flange will rest on sand, and thereby cause the flange of the wheel in casting to have a full and perfect edge. The "chill" is provided with a number of internal recesses, in which are placed cores, which form recesses in the rim of the wheel. These recesses in the wheel are filled up by driving roughened or file-cut pieces of steel therein, or by melting and passing therein hard metal, or they may be otherwise filled up.

Fig. 1.

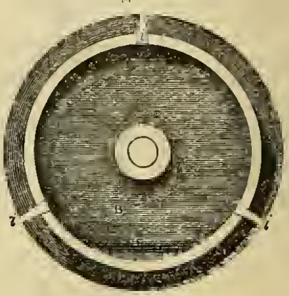
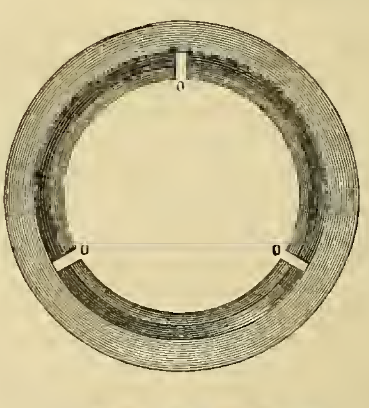


Fig. 1 of the engravings is a side elevation of the improved railway wheel; fig. 2 is a top plan view of the "chill" in which the improved wheel is cast; and fig. 3 represents a transverse section of the wheel and its "chill." In carrying out this invention the wheel and its "chill" may be of any known or suitable form, but a portion of the "chill," A, underneath the flange, X, of the wheel, is cut away (see fig. 3), in order that when moulding and casting the outer part of the flange may rest directly upon sand, whereby the said flange will, in casting, have a full and perfect edge. A number of recesses, O, are made in the "chill," and in these recesses are placed cores, which form the dovetailed recesses, *i*, in the wheel, B. These recesses in the wheel are filled up subsequently by driving therein roughened or file-cut pieces of steel previously hardened, or they may be filled up with hard metal introduced therein in a melted state, or other means of filling up may be adopted.

Fig. 2.



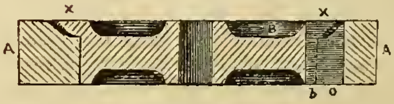


Fig. 3.

LAW REPORT.

UNITED STATES LAW CASE.

The Empire, Etna, and Finkle & Lyon Sewing Machine Companies *v.* The Grover & Baker, Wheeler & Wilson, and Singer Sewing Machine Companies.—New York Supreme Court, May 27. Before Judge Gilbert.—This is an action brought by the plaintiffs to protect themselves against published aspersions on their machines as advertised in the newspapers. The defendants are members of the association which had the control of Howe's, and still have control of the most valuable of the sewing machine patents, and demanded that plaintiffs should take out a license for the use of the patent for feeding known as the Bachelder feeder. The plaintiffs claim that there is no validity to the Bachelder patent, inasmuch as it was known and in use long before Bachelder patented it. Defendants demanded that all outside companies, including plaintiffs, should take out a license and pay a royalty on the machines of their manufacture as before. The plaintiffs refused to do this. It further appears that after the refusal on the part of plaintiffs to comply with this demand, defendants threatened to publish them as infringers upon the rights of said defendants; that as soon as such publication, as threatened, was made in the daily newspapers, the plaintiffs applied in this court for an injunction restraining the defendants from continuing the publication of their advertisement cautioning the public against purchasing the machines manufactured by plaintiffs. Motion is now made by plaintiffs that the court order the injunction to be perpetual.

The Court said that he deemed the case more properly as belonging to the jurisdiction of the United States Court. Messrs. Stoughton & Gifford, of counsel for defendants, stated that the question as to the mechanical merits of the respective machines would be in a large measure ignored, and that but a few minutes would be necessary on the part of the defence, whereupon the court decided to go on with the case.

Ex-Judge J. M. Van Cott made the opening argument for the plaintiffs. He said that the injunction was applied for on the ground that the defendants, or combination companies, were standing at the street corners, and at the doors of the plaintiffs' counting-houses, and were, in the advertising columns of the newspapers, warning people against purchasing machines manufactured and offered for sale by the plaintiffs. This course had amounted to an invasion of the business rights of the plaintiffs, and was prejudicial to an extent which was irreparable, and the action was brought on the general idea that the invasion of rights being irreparable, the Court of Chancery had the right to stop it. The object of the notice or caution published by the defendants was to the effect that plaintiffs' title to property in their machines was not a true and valid one. On the question as to the jurisdiction of the court, Mr. Van Cott said that when a collateral patent comes into question the state courts had jurisdiction, as also in relation to contracts to sell and convey patents. Plaintiffs invoked jurisdiction because, they having been engaged in the manufacture of machines, the defendants stood at their (plaintiffs') doors, and wanted their customers not to purchase their machines. As makers and sellers, they had no relief from the infliction of defendants except what they asked at the hands of the court, while the defendants had only to go into the federal court and procure an injunction on them. Defendants said they had suits now in progress in the federal courts for infringement of their patents, and he asked why they did not apply for an injunction on the plaintiffs, if they were infringing on their patents. The publication of the caution was to compel the plaintiffs to take a license in which all the patents were enumerated, and thereby admit the validity of the Conant patent, which was denied.

Ex-Judge Stoughton, for the defendants, said that their title to the patent was not questioned, as it had been admitted for years in the license the plaintiffs had taken. The notice which was complained of the defendants were bound to give, as had been shown in many previous cases. Patentees had stood aside and observed their inventions used without giving notice, and when they had sued to recover they found that their failure lay in the fact that they had not protested against the sale of their inventions by others than the patentees or those holding the patents.

Mr. Gifford, for defendants, said that in order for the plaintiffs to maintain their action the threatened act must be both alleged and proved. First, that the words of defendants were false; second, that they were maliciously used; and third, that the natural and legal effect would be pecuniary damages to the plaintiffs. Both malice and want of cause must be proven. Now, the plaintiffs had neither alleged nor proved facts sufficient to maintain an action. They were bound to show affirmatively a want of probable cause. This they had neither alleged nor attempted to prove. All the equities and material facts which were set up by the plaintiffs, and which tend to constitute a cause of action, were denied by all the defendants in their answer. The plaintiffs had entirely failed to make even a *prima facie* case, and the proof was conclusive that each of the plaintiffs' machines infringed upon numerous letters-patent owned by the defendants, and that, therefore, the complaint was false, and the notice to be published by the defendants was true. Counsel then proceeded to point out in what particulars the plaintiffs had infringed upon the patents of the several machines of the defendants.

The court, after several days' deliberation, decided that the motion to continue the injunction must be denied, and the injunction be dissolved with ten dollars costs.—*American Artizan.*

REVIEWS OF NEW BOOKS.

THE STUDENT'S TEXT BOOK, &c. By PROFESSOR NOAD. 1 vol. small 8vo. Lockwood & Co. 1866.

THE ELECTRIC TELEGRAPH By DR. LARDNER. New Edition by EDWARD B. BRIGHT, Sec. B. and I. Magnetic Telegraph Company. 1 vol. 8vo. Walton. 1867.

THE HANDBOOK OF PRACTICAL TELEGRAPHY. By R. S. CULLEY, E. Eng. Third Edition. 1 vol. 8vo. Longmans. 1868.

ON ELECTRIC MEASUREMENT, FOR THE USE OF TELEGRAPH INSPECTORS AND OPERATORS. By LATIMER CLARKE, M.I.C.E. 1 vol. small 8vo. Spon. 1868.

TELEGRAPHIC COMMUNICATION WITH INDIA. By FRANCIS GISBORNE, Esq. Pamphlet. Stanford. 1868.

OF this fasciculus of books on Electro-telegraphy there needs not much more be said than that they are neither much worse nor much better than the average style in which practico-theoretic works are commonly produced in Great Britain.

The authors generally know their subjects, and, no doubt, the practical ones amongst them are well able to employ their knowledge in practice; but what they know, if they know it in a symmetrical and systematic manner, they do not generally bring forth so.

The work of Professor Noad, at the head of the list, aims at being a general treatise, and not only is so, but we should be unfair were we to say it is not a good elementary treatise. But if we turn over its pages and compare them with those of Jamin or Dub, or a score of other continental like treatises, how much we must miss the terseness, method, and exquisite lucidity with which these abound, and with which science is always taught on the Continent. Mainly, this is because the teachers themselves have been well taught; they have not picked up their knowledge in crumbs how they may or can, here and there as with us: hence the orderly habit of thought that ever keeps the abstract and theoretic clear and distinct, and the debateable, and the practical application apart; with light shed upon them by the former, but that never clouded or shadowed by the latter. Mr. E. Bright's little volume, without losing the lucidity of what Lardner wrote (and no man of his day excelled more as a clear popularizer of science), brings the subject up to the last year. In this respect only does this work stand on a par with the volume on the like subject by Mr. R. Sabine (Virtue & Co.), which we noticed in this journal some months ago. In praise of Mr. Culley's work we cannot say very much, though we make no doubt the volume may prove useful to many an assistant telegraphic engineer, whose reading may or must be limited to English.

It lacks symmetry and method. Starting with the most abstract of all theoretic questions, viz., whether electricity be matter or force, it disposes, or rather does not dispose of that, say within thirty lines of its opening, by the sentence—"It is not necessary in a practical handbook to discuss questions which are simply hypothetical, *nor to enter into those parts of electrical science which have not an immediate bearing on telegraphy*;" and then it once more begins at the beginning by recording the ancient experiment of the Greeks with rubbed amber or sealing-wax, and so goes on for some pages, detailing the most elementary truths of electricity.

Now we make bold to say this, that no man is worthy to call himself an electrical engineer who has not mastered fully and completely the *whole* science of electricity, and not only so, but of magnetism, and of both in their relations to chemical action, to heat, and, in a word, to all general and cosmical physics. Well, if this be so, let the writer on electro-telegraphy take his choice: either suppose, as Mr. Latimer Clarke mainly has done, that his reader knows all this already, and plunge at once into methods, instruments, applications, modes of working, &c., &c.; or let him assume nothing of theory known, and then let him start by teaching that *first*, and finish it up, as our American neighbours express it, in a complete and orderly way, and then go to their applications and uses. But Mr. Culley, and a crowd of other authors on this and similar subjects in England, do neither one nor the other, but mix up the theoretic and the practical (that is the application) in such a way as gives the maximum amount of confusion and difficulty to the reader who approaches the subject for the first time, and simply disgusts the man who has already learnt in a better way, what he here finds in an *olla podrida.*

In the descriptions of his instruments and operative methods, we must not omit to do Mr. Culley the justice to say that he is clear and valuable.

Mr. Latimer Clark's elementary treatise, viewed as an office or telegraph workshop manual, will prove valuable for occasional reference, and it aims, apparently, at little more than giving in a condensed form, some of the cut and dry rules and methods which the author has employed in his own long and large practice as a telegraph engineer. These are given lucidly and briefly, and have fully the value we have just ascribed to them, in the hands of the already theoretically instructed student. The work, as a whole, however, is scarcely what we should have expected from the hand of a man with the electrical engineering reputation of Mr. L. Clarke, nor should we have expected him avowedly writing his first part "for the use of the student and the practical telegraphist who has not given much time to the study of his subject." These half-instructed people had better go back to school, and to the systematic and clear fountains of exact knowledge, and learn their elements first, and then they will want but little of Mr. Clarke's "colloquial" part, and will be well able to grasp the information he gives them in his second.

Why should an eminent man who has himself mastered his subject, condescend to write for and in a style to suit those who have only half, or less than half, learned it? This half learning of science, and for the sake of its applications—that is, for the money it can bring—is our national bane and disgrace.

To Mr. Gisborne's pamphlet we need only direct our readers' attention. It treats in a mercantile point of view the question of telegraphic communication with India, and more especially by the Central Asia line, in relation to which concessions have been obtained, and works are now in progress in this country.—Ed.

FOREIGN LITERATURE.

Œuvres d'E. Verdet, Vol. 2. Cour de Physique, Vol. 1. Masson et Fils, Paris. 1868.

The collected works of the late E. Verdet, the renowned and encyclopædic professor of the Ecole Polytechnique, are now in progress of publication by the grateful and affectionate labour and care of his former pupils in that noble school and of some professorial *confrères.*

The second and third volumes of the series, of which the first has just appeared, constitute a system of physics, as delivered in his biennial courses of lectures to the *elèves* of the Ecole during Verdet's lifetime, and extend to heat, magnetism, and electricity, in their largest aspects. The work is one that may take rank with that of Jamin, and has the advantage in a few points of being more recent. It is copiously illustrated with woodcuts, executed as Parisian scientific woodcuts alone are executed, and the large and marvellously cheap octavo volumes are printed in the usual superb style of Masson's house.

Vols. 5 and 6 of the series will consist of the higher physics, including physical optics, and 7 and 8 will embrace the mechanical theory of heat, as delivered in 1862 before the Chemical Society by Professor Verdet; a subject, however, also treated of with much lucidity in vol. 2.

Officieller Ausstellungs Bericht herausgegeben durch das K. K. Osterreicheichische Central-comité Leiferung. 1 nach 8. 8vo. Vienna. 1868.

These able and valuable reports by the Austrian Central Committee upon the classified objects of the late Paris Exhibition continue to appear, and are well worth the small sum at which they are sold, illustrated as they are with many lithographed plates, and woodcuts in the text.

Part 4 contains textile fabrics and papers, and is illustrated with specimens of the actual cloths and papers, including in the latter the curious and pretty crystallizateous paper of Kuhlman, of Lille.

Part 2, we should have previously stated, gives a capital account of nearly all the forms of permanent way exhibited at Paris, and of railway plant generally.

Part 6 contains, with a mass of fine plates, the motors and their parts—Classes 52 and 53, in fact. The portion on governors, by Herr Radinger, is extremely good.

Part 7 relates to agricultural products and methods, including therein the beet-root sugar industry, and brandy distillation and apparatus; and Part 8, the last which we have as yet received, contains agricultural machinery, including a set of important essays, by different authors, on cotton, wool, flax, oilseeds, and tobacco. We fear there will be no such series of reports as these produced, and as promptly, in England.

Etudes sur l' Exposition, of E. Lacroix, No. 21.

This useful work continues to appear with regularity, and the latest part embraces engines and apparatus applied on public works; sanatory, hospital, and medical apparatus; pumps and pumping engines, with which most of the plates of Part 21 are occupied; hunting and fishing, and their methods, &c.; and small arms, amongst which we look in vain for any further light upon the renowned *Chassepots.* It is rather amusing to an Englishman to observe that in anything that relates to British armaments French publications are prompt, full, and precise, thanks to our freedom from trying to keep secrets; but as respects any information about what their own government departments may be doing, if they get at them at all, it seems to be first of all through some Prussian, Belgian, or English publication. If a French iron-shipbuilder, or cannon founder, or mechanical engineer, work for his own government, it seems to be by some sort of tacit understanding agreed, that if he gives any information to third parties he forfeits government patronage. It seems hard for any people thus hedged in, to exercise any control over the warlike doings, however extravagant or mischievous, of their own government.

Bericht uber die neuesten Fortschritte im Eisenhuttenwesen, &c. By Knut Styffe. 1 vol. small 8vo. Plates. Felix, Leipzig. 1868.

This useful pamphlet, for it is not much more, consists of the account of all most new and noteworthy as regards improvements in iron manufacture exhibited at Paris in 1867, extracted by Knut Styffe from the Jernkontorets Annalen of Professor Von Tunner for last year. It is limited to the improvements of France and Prussia, and hence leaves a good many important things unnoticed, and even in France we miss some objects which in our judgment were well worthy of notice.

Rapport sur les Progrès de la Geologie Experimentale. Par A. Daubrée. 1 vol. 8vo. Imp. Impl., Paris. 1867.

This is one of the volumes of the magnificent series of reports by various eminent men, now in course of publication by the government of France, upon the progress made during this century, and the present state of almost every branch of science and literature. We notice this volume, which primarily addresses itself to the higher school of physical geologists, one which unfortunately scarcely can be said to avowedly exist in this country, chiefly because it is of interest to the mining engineers, and because the chemist, the mineralogist, and the cosmical-physicist will find in it the most lucid and interesting classification and generalizations as to meteoric stones which we have met with.

Die Industrie der Mineralöle des Petroleums, Paraffins, und der Hartze. Von H. Perutz, Tech. Chem., &c. Vienna. 1868.

This small octavo volume is quite an encyclopædia of information as to all that relates to the natural habitats, methods of winning and working oil wells, uses of the products, raw or refined, for heat, light, and manufacture, and, in a word, of the entire range of mineral-oil industry.

A good many wood-cuts are intercalated in the text, and amongst these will be found several of the arrangements of apparatus that have been found more or less adapted abroad for the combustion of petroleum as fuel, and one or two very ingenious contrivances for vaporizing the more volatile oils distilled from it, by the aid of their own heat of combustion, so as to produce a succedaneum for gas light. Those interested in this special industry ought to be in possession of this work. It and a little volume now some time since published on the same subject in French, would be worth an English translation of a condensed kind.

Erlauterungen zu der geognostischen Karte vom Niederschlesischen Gebirge herauggegen. Von Justus Roth. 8vo. Berlin. 1867.

This volume, commencing, as now so usual and so good in many German works of science, with a fine bibliographical table of the author's, and references to all prior works treating of the subject, is an elaborate and able sketch of the geology (in all its relations) of one of the most interesting mountain lands and valley plains of Europe, viz., those of Lower Silesia—the cradle of some of the most remarkable iron and other metallic industries of Europe, and the scene of more than one memorable military struggle, including that of Napoleon I. at Friedland; and the last, that of the year before the last, which ended with Sadowa.

It is not a little curious that from Berlin should come forth this able piece of topographical geology of the late Prussian seat of war, illustrated by one of the best-executed geological maps in colour printing we have ever examined. The country described, embracing no less than twenty-four systems of rock formations—from the most recent Alluvium down to Gneiss—is of high interest to the geologist proper, as well as to the mere travelling man of any scientific information and taste, and to the technologist.

Geschichte und Beschreibung der Vulkanishen Ausbruche bei Santorin, &c., &c. Von W. Reiss und A. Stubel. 1 vol. 8vo. Heidelberg: Bassermann. 1868.

This is an example of German care, patience, and exhaustiveness. It is, in fact, a complete monograph of the volcano of Santorin, tracing its history and successive changes and outbreaks from the earliest historic notices down to the recent great eruptions of 1866, and with some original research interspersed and added. The bibliography of the subject of this remarkable "between-wind-and-water" crater, which is given at the commencement of the volume, is worth the whole of its price.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

IRRIGATION.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—The inclosed letter and extract have been printed by the *Morning Post* to-day. I have sent it to several of the London papers. I cannot think of anything of much more importance to the country at the present time, everything seems so parched. I am now living at Chester, overlooking the beautiful river Dee, with brown meadows on each bank. I spent the summer of 1847 in the Tyrol, and was delighted to observe the plan of irrigating by large water-wheels, with buckets attached, all along the line of the Brenner Pass, and regretted at the same time to hear the dismal accounts of the Irish famine. The English do not appear to have learnt the system of watering their fields from the Tyrolese, although we have taught them to make railways; therefore I hope we may not be too proud to receive instruction in return.

I remain, yours very truly,
C. BUTLER CLOUGH.

Boughton House, Chester, 11*th June*, 1868.

(*To the Editor of the Chester Courant.*)

Sir,—The continuance of dry weather makes one wonder why the system of irrigation so common in other countries should be neglected here. It seems as if we wanted the Imperial Waterworks described in "Through Spain to the Sahara" (extract appended) to supply the tanks recommended by Mr. Disraeli at the agricultural dinner in Buckinghamshire.—I am, Sir, yours, &c.,

C. Butler Clough.

Boughton House, Chester, 6*th June*, 1868.

"We had brought other letters to Le Sig, and by one of them were introduced to a charming young English lady (Madame O——), who had spent all her life in Africa, and was now settled down at Sig. Her husband was a Frenchman, and held an official post of some authority there, being entrusted with the supervision of the gigantic barrages or waterworks which are turning the barren plain of Le Sig into gardens of beauty and fruitfulness.

"When the Emperor was at Algiers he asked some great authority on Algerian affairs what was most needed in the colony.

"'Barrages, Sire,' was the answer.

"'Et après cela.'

"'Encore barrages,' repeated the political economist; and the Emperor gave heed to the words, as those who follow in our track from Oran to Algiers will see. These gigantic and noble works are well worth inspection, especially at Le Sig; and if future travellers have the good fortune that fell to our share, they will come away with a very clear idea of the importance and working of these monstrous systems of irrigation."

[*Note.*—The reason why irrigation, except in the specialty of "water meadows," is so neglected in Great Britain and Ireland, is simply that, as a rule, we don't need it. The present parching summer is exceptional. A severe drought once in from nine to eighteen years or so would not justify the expenditure of capital for universal works of irrigation, which in the intervening years would be useless and unproductive. Irrigation, universally applied, is for tropical or semitropical agriculture, and is to that what arterial and subsoil draining are to our temperate and usually dripping climates.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF NAVAL ARCHITECTS.

THE TESTING OF IRON BY MAGNETISM.—By S. M. Saxby, Esq.

(*Concluded from page* 92.)

Now, the amount of magnetism in a piece of iron (or rather the amount and peculiarities of polar condition in a piece of iron) are measurable; therefore, if strength in iron is magnetism, so is strength in iron mensurable; and as any common compass is a magnetometer, so ought we by the use of a compass to be able to measure strength in iron and detect its weaknesses.

And this is all I pretend to be able to do. But lest the old-fashioned notion should still cling to the minds of some, whose avocations have kept them, as regards magnetism, out of the influence of that stream of knowledge which is ever on the onward move, I would ask leave to produce the results of an experiment which I think settles at once all controversy as to the penetrability of a mass of iron by magnetism. It is the only point on which those who have fancied it was to their interest to suppress a means of detecting faults in forging iron (faulty weldings, &c.) have attempted to base any opposition to my views; and unless this be cleared from all doubt, my pretensions must fall to the ground.

This is a wooden model to full scale of a piece of round bar iron 14 inches long and of 4 inches diameter.

The piece of iron which it represents was prepared, as to size, under my directions, in order to test the power of a magnet over the interior of a solid mass; and as I am not aware of any direct experiment having been recorded on the subject, I would ask leave to give some rather important, perhaps interesting, details. By permission of the captain-superintendent, I requested a most able and intelligent master smith at Sheerness to heat the mass to a bright heat, to slit a hole in the side of it at the middle, and while hot to drive in a piece of steel, so that it might be exactly in the axis of the bar. Instead of complying, he thought it better (as it undoubtedly was) to drill a ½ inch hole in the axis of the bar from one end, drop in a steel pin, and then cautiously and partially, as he thought, weld the mass together, so that I should have what I wanted, viz., a piece of steel imbedded in a solid coating of iron in every direction, quite away from the surface, but in such manner that neither the situation, nor size, nor shape, nor condition of the steel should be known to me previous to testing (nor had I the least idea of either; indeed I tested under the impression that he had complied literally with my request). I mention these details, because the value of the experiment depends entirely upon them, and they will convey to you those insights into the power of magnetic testing, which, without them, would need a great deal of illustration. It is better to describe in detail one experiment than to imperfectly glance at many.

I naturally felt with my compass carefully about the centre of the bar in this manner, but could find no steel there, and at once said so (fully then expecting some trick); but the master smith said that he *had* inclosed the steel. Under some very natural but momentary perplexity (for it was a most severe trial) I carefully ran my compass up and down the side of the bar (thus), placed the iron *in* the magnetic meridian, *out* of the meridian, in the line of magnetic dip, &c., until corroborations of compass disturbance near one end (just here), advised me of evident local interference with, or disruption of, that molecular "alternate polar continuity" to which I have called attention—placing as I now do, a chalk mark, saying, "The pin is here. Am I right?" He replied, "Not exactly." I requested him to lay off with his rule the exact position of the pin, instead of which he merely said, "That is only one end of it; where is the other?" I could not at first, with certainty, find it, and here my experiment might have ended, but I had noticed that the needle showed diminishing unsteadiness as it approached the one end of the bar. A moment's consideration, therefore, convinced me, and I confidently declared, that the one end of the steel pin, as at first detected, could not have been properly welded into the mass of iron: that the other end must have been thoroughly combined with the iron. The master smith then accurately measured off the position of the pin, and punched in both my chalk marks and his own marks, to fix them.

Perhaps, however, I have yet to state the most extraordinary and most significant result of this examination, consequences which, I believe, if followed up in a right spirit, will prove an immense saving of public money.

With all brevity I will say, that next morning I obtained leave from the colonel-commandant of Sheerness garrison (Colonel Crofton) to try my hand at testing a large gun; and supposing that an Armstrong was more complicated in its make and form than others, I obtained permission to test a 40-pounder Armstrong for flaws or fractures. Within half a minute's testing I had exclaimed to Lieutenant Gaimes, the gunnery instructor (who had kindly placed the gun for me in the magnetic equatorial plane, E. and W.), "Something wrong here," and on again using my magnet (the one now in my hand), "I can trace something wrong, and a fault of some sort runs half round the circumference of the gun," and I traced a spiral curve with my finger (I had then no idea that the barrel was made up of coils). On his sending his sergeant for the gun's register (No. 133), he read in it the record of a flaw not far from the muzzle, *just under* where I had marked it.

With equal facility and success, on the same occasion, I tested two 32-pounders and three small-arm barrels, in each case pointing out defects which had been previously known to the sergeant armourer to exist, but not even suspected by myself, the lieutenant watching with much interest the action of my testing compass and confirming the accuracy of my deductions from its motions.

Thus, Sir, I presume to indulge a hope that I shall, in due time, contribute not only towards a source of great national economy, but add an additional safeguard to the gallant hearts who man our guns both at sea and on shore.

I was soon afterwards describing my success with the steel pin in the mass of iron, when it was kindly hinted to me that it was all very well to state my opinion as to the condition of the pin, but that, with strangers, some ocular demonstration was necessary. I therefore had the bar cut; and, to avoid the destruction of the precise end of the unwelded part, I had my first cut made so as, if possible, to show it. It proved that I was correct, for one end is *not* welded and the other *is;* and I have the pleasure of producing an unimpeachable proof of the soundness of the principles on which I found my test by magnetism in showing you that specimen itself.

Now if Professor Barlow were living, *with his opinions still unchanged*, he would probably assert (as a few of his disciples still do) that magnetism cannot penetrate beyond the mere surface (I think the tenth of an inch has been mentioned as the limit), and he would quote his celebrated experiment of the sphere or short cylinder of iron. But Dr. Scoresby, from his very elaborate investigations of iron of all shapes, fully explained this. We cannot too carefully guard ourselves against misconceptions in the early stages of discovery.

The case is simply this: I have never seen it satisfactorily explained by direct experiment, and offer my solution with all due deference. Whatever else may be the properties of magnetism, which under some circumstances it is known to possess, certain it is that its molecules (if we may so speak of minute portions of a merely imponderable influence) have a powerfully *repellent* property, *such* as we see when we put together the *like* poles of the magnet. That is to say, if we take, for instance, a 2 feet bar magnet, nearly all the magnetic force it possesses will be found not equally distributed through the bar, but accumulated near its ends; and the longer the bar in proportion to its diameter the more the force would, I believe, collect near its ends, and (*per contra*) the shorter the bar the more equally would the repellent force be distributed about the whole mass of the bar, until, when every part of the surface was at an equal distance from the centre of gravity (as in the case of the sphere *absolute polarity would be scarcely perceptible*), the cube and solid cylinder would, of course, exhibit rather more polarity, but still it would be but feeble.

Now suppose we have a sketch of a square bar magnet of some length; were it possible to instantly detach a portion from the centre of the magnet, without any disturbance of magnetic force, that portion would be a fair representation of the condition of Barlow's sphere and cylinder, or cube, or any dumpy form, in its imperfectly polar condition. Hence we see that it *is* difficult to apply a magnetic test to such a "dumpy" mass. I admit this, nor was Barlow wrong; but fortunately for us, such pieces of iron, forged on an anvil, *never require* being tested for strength; therefore, as an objection to my system, it is totally unimportant.

It would be difficult to condense within the expected limits of this paper even an outline of the extent to which the question of a reliable magnetic test might influence the work of the builder of iron ships. The huge forgings of parts of our ironclads are of the first importance.

It might seem to be hopeless to look for any means of testing these; but be it remembered the laws under which one tests with a small compass are immutable. We may as well declare that the huge stern-post of the magnificent *Hercules*, lately launched at Chatham, could not have been forged at all, because of the customary smallness of the ordinary smith's furnace.

We have only to imagine the substitution of a larger and more perfect form of testing magnet for those in present use (and more intelligence and more experience in those who use them), and there opens before the mind's eye a prospect which may at least encourage us to attempt the solution of those problems as to crystallization and fibrosity, which all admit are loudly calling for investigation; and every step we take in examining into the molecular condition of iron and steel (even such a mite as I am now hoping to contribute), will, if accepted in a cherishing spirit, and in a manner free from prejudice, benefit in some way the interests of this great commercial kingdom.

To use this magnetic test effectually, a fair knowledge of the main points of terrestrial magnetism is indispensable; but where, at the present day, is the master smith (or his assistants), who are unequal to a comprehension of it? Let it even be that in due time an officer be attached to a testing room in every factory where iron articles are forged or iron made, and it will amply remunerate.

And further, if we consider for a moment the importance (what I beg now to suggest) of more attention being given to the mode of *casting* iron, we shall desire more strongly a better acquaintance with the method in which we can best secure the *greatest strength from the least quantity of metal.* My early experiments showed me that in this respect the prevailing process is defective.

The want of a convenient and better mode of testing (in fact, the want of a better estimation of what I have called the "continuity of alternate polarity") has been a source of much weakness in iron castings. It has, moreover, been a source of waste; customary fractures occurring at particular parts of an article naturally lead to the strengthening of those parts with additional metal, whereas, according to my observation, I believe in many cases that such weaknesses arise from the *imperfect manner in which the molten metal is run into the mould*; for unless the junctions of the surfaces of the hot metal occur at the *same temperature*, the molecular condition is defective. It is nothing uncommon with me to find opposite polarities occurring in castings within the space of small portions of an inch. *Now these are equivalent to flaws in wrought iron;* they are absolute weaknesses, and in most cases easily remediable. Irregularity of cooling causes molecular disruptions.

There is but little difficulty in the testing of many articles, such as shafts and spindles, axles, girders, braces, knees, railway wheels, and so on, and especially such articles as revolve in a lathe during manufacture. Among these in particular are gun barrels; and perhaps I cannot better employ a few remaining minutes than in adding a few remarks on this, I believe, nationally important branch of my subject, and especially as it bears much on the safety of sailors working guns in a turret or between decks.

I believe guns upon the largest scale are being built up of a stout iron or steel internal cylinder, and various outer cylinders.

The two 32-pounders which I tested were of this kind, and yet I found no difficulty in testing them. But how much more conveniently could I have tested each part separately, before being put together? How much more thoroughly, had I been permitted to practise for a day or two (as I volunteered to do) at Woolwich, a few months since, I should have increased my experience? In the case of small-arm gun barrels, how much easier to test them before the additions of staples and portions of iron or steel, which are braced on to complete the barrel, than with all the complications they afterwards cause in testing by magnetism?

I scarcely doubt that we shall before long be able in a great measure to dispense with proving guns by gunpowder, confining its use in testing to the proving of those guns only which give unsatisfactory results with the magnetic test. We should thus be substituting in magnetism a perfect method of proof for an imperfect, because that by gunpowder is only partial and limited to the quantity of powder used.

A few very brief remarks as to power of testing by the compass will convey ample information as to its value.

The piece of iron marked M was brought to me for my opinion; it was said to be good, but I marked it as faulty, and on cutting it at the mark such was found to be the case. It was the same with the piece marked N. I have dozens of similar specimens. The two bars marked S M S are samples; the round one of good iron, the square one of bad.

My very few examinations of rolled plate have led me to suspect that electricity (of which magnetism is, of course, a mere condition) possesses a property in some measure analogous to that pertaining to light when passing through media of different densities; if so, this would explain the difficulty I experience in testing plate-iron known to be laminated. At Chatham I pronounced a plate to be "good" in quality (as it proved to be); it was stamped "best best," which had very extensive laminations, and this called my special attention to some peculiarities I had not before witnessed, and which I for the first time make public.

Now, in penetrating a substance, light is subject to three different laws, viz., reflection, refraction, and dispersion. Viewing electricity as but another imponderable influence (if it be right to speak of it as a distinct influence), it is easy to conceive that electricity may in like manner be subject to a law of dispersion. If it be so, it would account for the distortion of what (when a rolled plate stands vertically east and west) *ought to be* the place of the equatorial plane, viz., at right angles to the line of magnetic dip. This law of "dispersion," if applicable to electricity, is possibly evidenced by, and may be the cause of, the zigzag process of a flash of lightning as seen on a large scale, as it passes through atmospheric stratifications of different densities, and on a small scale may be seen in the examination of a powerful electric spark by means of photographic paper.

But allow me a passing word or two as to this suspected law of magnetic dispersion. Now we are accustomed to associate in our ideas light, heat, and electricity, as if identical But it is as easy to suppose that light and electricity are the same, as that light and heat are so.

Both Professors Stokes and Tyndall have already demonstrated that light and heat are the same thing. May we not, then, when obscure facts point to some novelty in the use of magnetism, and lead us directly to notice an unexpected apparent "divergence," may we not, I say, reasonably suspect its cause to be that property of dispersion which is known to exist in light, and which, if light be identical with electricity, may also exist in magnetism? I submit to the distinguished men who compose this assembly that an investigation of this part of the question seems to be very desirable, from the immense consumption of plate iron by iron shipbuilders, and the great loss attending the present means of destructive testing.

My humble suggestion becomes strengthened when we recall to mind the assertion of a surveyor of the Board of Trade, made in this room in April last, who said "that the great difficulty that has to be overcome is the *want of reliability* in a number of the plates supplied to steel ships; for although we may find two or three plates in a great number that may be bent and twisted, and worked into any shape, yet it is quite probable that the majority of plates delivered in that parcel may be quite unfit for use or safety, if put into the bottom of a ship." He added, "one of the angle-iron frames was put under the shears in my presence, and fell in three pieces like a piece of crockeryware."

It is remarkable that in general we know less of the *condition* of iron than of its *quality*. The best of iron, when in bad condition, is virtually bad iron.

I could give a striking example of the necessity for greater attention to condition, when I allude to what is known as "Bowling iron." It is costly, and bears the highest character. I did not specially select it for scrutiny, and if I notice what would appear to be an imperfection in it, such imperfection is not, I am bound to say, confined to Bowling iron, as specimens on the table of iron of high repute will prove.

But Bowling iron is certainly that which has caused me great surprise in testing, and as it is used whenever great tensile strength is called for, my magnetic examination may possibly be turned towards their own interests by its manufacturers. Certainly we need some better means of testing the *condition* in which accidental circumstances may place the best of iron.

Now, the characteristic of Bowling iron seems to be its great toughness—its tensile strength: but my experience in testing points prominently to the fact that such toughness is in connection with great aptitude for lateral separation of its fibres, and a strong tendency towards *partial* crystallization; and as absolute perfection of strength is incompatible with a want of uniformity of condition, I cannot, in my humble judgment, avoid the conclusion that much of what iron I examined at Chatham Dockyard as "Chatham iron" is for general purposes, and from the absence of this tendency in its fibre to separate laterally, even, if possible, superior to Bowling.

I wanted to procure at Chatham a sample of the very best iron which experience could select for me as a standard of purity. The master smith employed one of his best workmen to work a carefully chosen piece down to $\frac{1}{2}$-inch square bar. But what was our joint astonishment to find the testimony borne by my compass to be *depreciating?* My compass showed the condition to be *unsound*, and I marked the spot it condemned. On cutting the bar at my mark it was found to be *partly* crystallized and *partly* fibrous, and therefore of different strengths in portions of the same section. What other test could have detected this?

And, again, the specific gravity of Bowling iron varies very considerably. Taking for comparison the specific gravity of the best Swedish to reach 7·86, I find one sample of Bowling to be 7·878; another was 7·874; another 7·775; while another was as low as 7·613. Now, in all these specimens (which I have with me) I beg to call attention to the *fractures* they exhibit, *defects* which would be quite unlooked for in iron of such purity as the specific gravities would indicate (7·7 being the average of good bar iron). From many testings of Bowling iron I should almost have ranked it with steel.

I should be exceedingly sorry to be misunderstood in my remarks as to Bowling iron, and will now show a sample which can scarcely be surpassed for toughness, although on cutting it where it disturbed my magnet I detected a fault. Perhaps Dr. Percy is not far wrong when he tells us that "the occasional, *perhaps accidental*, introduction of bad ores, and other causes, may at times produce inferior qualities of iron." I can only appeal to facts. I may have been unfortunate in my selection of samples, but the majority have been selected for me. Here are several on the table.

A few noteworthy defects in the common mode of forging iron have been detected by the magnetic test. For instance: the upsetting of a piece of iron should always be done at as near a wielding heat as possible. If otherwise done, it causes a flaw perceptible to the magnet, and here let me remark that many faults in condition might be remedied by annealing. As an instance: at Chatham my attention was called to the fracture of a long piece of 4-inch square, which was being forged out of best scrap. During manufacture it broke in two, near the slings, certainly from vibration having caused it to crystallize. I believe it to have been carefully worked, and very good in quality; but the condition, had it not broken, would doubtless have been greatly benefited by subsequent annealing. And again, experiments have shown me, that whether iron be forged in one direction or another as regards the magnetic meridian, so will its *strength* vary. Samples on the table illustrate this. Indeed the specimens, *c* and B and D, I pronounced at Chatham to have been *most certainly* forged in a N. and S. direction. Hence we may reasonably question whether all testing machines should not be placed in a direction of E. and W., and for chain cables especially, in the iron of which we wish to avoid destruction of elasticity.

And again, in welding iron, it is bad to use the ends bevelled, laying pieces of *filling-up iron across* them. This *crossing* of fibres, even after a sound weld, is an element of weakness, and it has been clearly proved by the magnet test to be very objectionable.

We have already, therefore, seen some benefits from testing by the simple pocket compass, and such as they are, I beg to offer to the public.

I beg to apologize for occupying so much time, and I will conclude by showing the difference between the action upon the magnet of *good* iron and of *bad* iron. Whether this square bar be bad iron in quality or iron tampered with, I cannot say. I suspect some trick in it, but know nothing of its history except that it was brought to me, with others, a year since as a piece of unsound iron. It is much at the service of any gentleman who likes to test it and have it cut where I have marked it, so that it be restored to this room before the close of this session of the Institution.

ON THE STABILITY OF MONITORS UNDER CANVAS.

By E. J. Reed, Esq., Vice-President, I. N. A.

The proposal to mast monitors and to send them to sea as full-rigged sailing ships has been so often made, and urged upon the public with so much zeal, even by persons claiming to speak with weight upon questions of naval construction, that I have deemed it desirable to lay before the members and friends of this Institution a few considerations which will exhibit some of the dangers of such a course, and which will at the same time present a few examples of what are certainly very interesting and exceptional cases of "stability."

Permit me at the outset to say, that I employ the term stability in the sense in which it has hitherto been used in scientific works upon naval architecture. In nautical parlance the word is often employed as the synonym of *steadiness*, the *Achilles*, for instance, being in this way pronounced the most "stable" ironclad in the Channel squadron. This, however, is not at all the scientific sense of the term stability, for in that sense the *Achilles* is (for her size) the least stable of the ironclads, and, in point of fact, owes her superior steadiness to the very circumstance of her stability being so small. The *Bellerophon*, which is, I believe, next to the *Achilles* in *steadiness*, is next to her also in the smallness of her *stability;* while the *Lord Clyde* and other ships of much larger stability are correspondingly deficient in the quality of steadiness. It is to be regretted that this discrepancy exists between the scientific and the nautical use of the term; but the fact of its existence should incite both seamen and naval architects to cultivate a mutual understanding of both uses of the word.

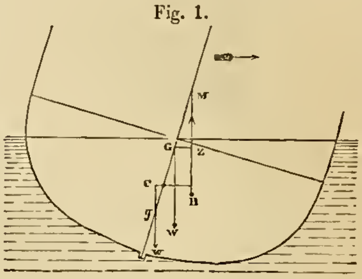
In naval architecture—forgive me for detaining you a moment while I reiterate an elementary fact or two which may help this mutual understanding—the word stability is applied to the effort which a ship makes, when inclined, to return to the upright position. If she is urgent to return to it, she has great stability; if slow to return, she has small stability: and the fact to be chiefly observed—for it exhibits the cause of the discrepancy in question—is this, viz., that a ship which is reluctant to move out of the upright position in still water, and urgent to return to it, is usually the most urgent to obey the fluctuations and impulses of waves. We naval architects say such a ship is too stable—seamen say she is not stable enough; and I must say that our use of the word is a mere fair-weather use of it, and that we must forgive naval officers if they laugh at us for pronouncing a ship stable in proportion as she rolls about in waves at sea. Still, our use of the word is a perfectly legitimate one; it is too firmly built into our scientific terminology to be removed, and all we can do is to endeavour to make it as well and widely understood as possible.

Strictly speaking, stability, in our sense, is of two kinds—statical and dynamical. Permit me to briefly explain both. Fig. 1 represents the section of a ship heeled over to a certain angle: G is the position of the centre of gravity of the ship; C and B are the centres of buoyancy in the upright and inclined positions respectively; B M is a vertical line along which the buoyancy of the ship acts upwards; G W, a vertical line along which the weight of the ship acts downwards. These two forces form a couple, the arm of which is G Z, tending to restore the ship to the upright position. The moment of this couple is called the moment of statical stability: and since the weight and buoyancy are constant whatever the angle of heel may be, the length of the arm, G Z, will be a measure of the statical stability.

The dynamical stability is the mechanical *work* necessary to heel the ship over to any angle. It may be measured in two ways—either by taking the sum of the distances through which the centre of gravity ascends, and the centre of buoyancy descends, in moving from their vertical into their inclined positions, and multiplying by the weight of the ship; or by means of the formula:—Dynamical stability $=\int M d\theta = W\int r d\theta$ where $M =$ the moment of statical stability and r the length of the arm G Z of the couple, at an inclination θ $W =$ the weight of the ship.

Now I think it will be seen, upon consideration, that the security of ships of the ordinary form, when under canvas or rolling in a sea-way, against being turned over by a sudden gust of wind, or by a deep roll, depends in a great measure upon the fact that the moment of statical stability increases with the angle of inclination, which it generally does, nearly in proportion to the angle of heel. In the case of a ship under sail, in smooth water, the angle of heel increases until the moment of statical stability is equal to the moment of the wind upon the sails; and this becomes a position of equilibrium if the force of the wind remains constant. In order that this inclined position may be one of stable equilibrium, it is necessary that when the ship is moved from this position towards the vertical, the moment of stability should decrease and become less than the moment of sails; and that when she is heeled over further from the vertical, the moment of stability should increase, so as to exceed that of the sails. Or, in other words, in the neighbourhood of this inclined position of equilibrium, the moment of statical stability should increase as the angle of heel increases.

Fig. 1.



The conditions are the same for a ship carrying canvas in a sea-way. But since the rolling caused by the variation of the wave surface, and the variation of the force of the wind, takes place about the inclined position of equilibrium, and is more likely to be considerable than the effect of the variation of the wind alone in still water, it becomes necessary that the conditions above stated should not be confined to the neighbourhood of the inclined position, but should extend on both sides of it to a safe distance beyond the probable extreme inclination of the ship to the wave surface.

If, however, the stability—and by stability I must be understood to mean the moment of statical stability, when not otherwise stated—of any class of ships increases as the ship heels over, until when she reaches a certain angle it becomes a maximum, and then decreases as she still continues to heel over until it passes through zero and becomes negative, there will be three positions of equilibrium of the vessel, one of stable equilibrium in the upright position, and one of unstable equilibrium on each side of it at a certain angle of inclination. And if these positions of unstable equilibrium occur within the limits of roll of an ocean steamer when not under canvas, the ship will evidently be unsafe for sea-going purposes. It will also be shown that, although the positions of unstable equilibrium fall beyond the limit of rolling, if they fall near that limit, the ship may be safe under steam, but may be totally unfit to carry sail.

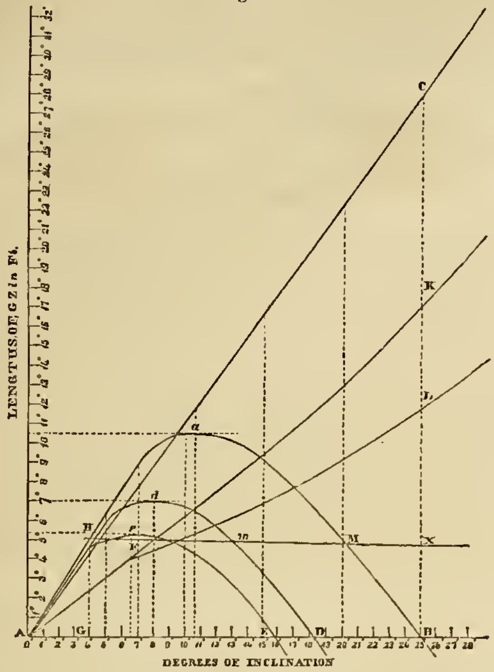
The first condition to be fulfilled to enable a ship of the latter class to carry sail will evidently be, that the moment of sails at any time shall not be greater than the maximum statical stability of the ship. Now, suppose this condition fulfilled, and the ship heeled over, under the influence of the wind, to some finite angle less than that of greatest stability. It will be seen that, if by any disturbing cause, such as the alteration of the wave slope, the ship were inclined beyond her position of maximum stability, the resistance to heeling would become less the farther she went, until she reached a position at which her moment of stability would be the same as before the disturbing force began to act. And in this position she would remain in unstable equilibrium if the disturbing forces were removed. But if she would pass this position before the disturbing forces, and the angular velocity caused by them, cease, the ordinary moment of the sails will then be greater than the resistance offered by the stability in any other position through which she will pass, and she will be turned over. General considerations led us, of course, to foresee that the above critical state would be likely to occur in low-decked turret ships with great weights concentrated upon and above their decks; but in order to find out more definitely how the stability did vary in this class of ship as compared with that of ships of a high freeboard, two ships were taken, viz., the *Duncan* cut down to a freeboard of 3 feet 6 inches and fitted with two heavy turrets, and a ship with the same displacement and immersed body as the *Duncan* when so cut down, but whose sides were continued up like those of an ordinary ship, observing that the centre of gravity was estimated to be in the water-line in the latter case, and ·2 of a foot below it in the former case. The moments of statical stability and the lengths of G Z were calculated in each case at every 5° of inclination, and the results are laid down on the diagram shown in fig. 2. In this diagram, the angles of inclination of the ships are marked along the base line, and the corresponding ordinates of the curves represent the lengths (on the scale marked on the left hand column) of the arm (G Z, fig. 1) of the couple, at the ends of which the weight and buoyancy of the ship act, tending to restore her to the upright position.

The line A *a* B, fig. 2, shows how the stability of the *Duncan* monitors varies for the different angles of heel. Her moment of statical stability increases nearly in proportion to the angle of heel through an inclination of 7°; the deck then begins to be immersed, as shown in fig. 3, and the stability increases less rapidly, until the ship reaches about $10\frac{1}{2}°$, as in fig. 4, at which inclination the stability is a maximum. It then begins to decrease as the angle of heel increases, and she loses all stability before she is inclined to 25°, arriving there at a position of unstable equilibrium, and past this position her tendency is to turn over still further.

The line, A C, fig. 2, shows how the stability varies in the ship of ordinary form. And it will be seen that the moment of stability goes on increasing through very large angles of heel, nearly in proportion to the inclination.

Hitherto I have referred to the case of a monitor with a freeboard of 3 feet 6 inches, which is far more than the American monitors have possessed, and much more than has been contemplated by many persons who have proposed the adoption of sailing monitors in this country. It is also certainly a greater freeboard than most of our line-of-battle ships would possess if cut down and weighted with armour and turrets to the extent which has sometimes been recommended, and especially more than we could depend upon getting if they were placed for conversion into the hands of any one not capable of resisting the temptation to produce a formidable-looking ship on paper by adding armour regardless of weight. I have, therefore, taken the case of the *Duncan* monitor with increased draught so as to give a freeboard of 2 feet 6 inches, and also with a freeboard of 2 feet, and have shown, by means of the curves, A d M, and A e E, fig. 2, how their stabilities vary. I assume the centre of gravity to remain in the same position as before relative to the ship, and therefore to be 1·2 feet below the water-line in the former case, and 1·7 feet below it in the latter case. In the former case, viz., with the freeboard of 2 feet 5 inches, the stability increases until the ship is inclined to an angle of 5°. The edge of the deck is then immersed, and as the ship goes on increasing her angle of heel the stability increases very slowly, until it reaches a maximum at 8°; it then decreases, and the ship reaches a position of unstable equilibrium at 18½° inclination.

Fig. 2.



.Fig. 3.

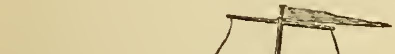
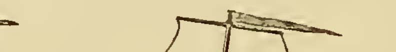


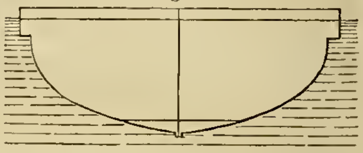
Fig. 4.



In the case where the freeboard is 2 feet, the edge of the deck is just immersed when the ship is inclined to 4°; up to this point the stability increases nearly the same as in the other cases, and it will be seen that it has then almost reached its maximum value; it increases slightly until the angle of heel reaches 6½°, and then decreases as the angle increases until the ship becomes unstable, which takes place before she has reached 16° inclination.

I will here explain what seems at first sight to be an anomaly in fig. 2. We see that the curve, A C, lies inside of the curve, A a B, at the small angles of inclination, that showing that in these two cases, and in these positions, the monitor has the greater stability. This is, of course, due to the fact of her centre of gravity being the lower, while both the displacement and load-water section are the same in each case. But the curves, A d D, and A e E, also fall inside of, A a B, at first, although the centre of gravity in the two former cases is much farther below the water than in the latter. This apparent anomaly may be explained in the following way:—The moment of inertia of the water-line remaining nearly constant as the ship sinks in the water, while the displacement increases, causes the distance between the metacentre and centre of buoyancy to diminish; at the same time, the centre of gravity descends faster than the centre of buoyancy, and consequently approaches it. Now if the metacentre approaches the centre of buoyancy faster than the centre of gravity approaches it, the distance of the metacentre from the centre of gravity, and with it the arm of the lever, G Z, (fig. 1), will be diminishing, and this is just what occurs here.

Fig. 5.



It is interesting also to compare the dynamical stabilities, or mechanical work necessary to heel these ships through equal angles. This may be done by comparing the areas inclosed (in fig. 2) between the base line, the curves, and the ordinates drawn to the curves at the particular angles of heel. That these areas are proportional to the dynamical stabilities may be seen from the formula given before, viz:—

$$\text{Dynamical stability} = D \int r \, d\theta.$$

If we take the case of the first monitor being heeled over to the position, H G, fig. 2 (4°) under the pressure of sail, and draw the line, H m M, so that it shall represent the variation of the moment of sails due to their inclination, and suppose H m M also to represent the effect of the sail upon the other ships, it will then divide each of the areas, A C B, A a B, A d D, and A e E, into two parts, the lower of which will represent the work which the wind (at a constant pressure) would be capable of doing in overturning them, and the areas above the line, H M, will represent the whole of the energy which the ship could put forth to withstand any additional impulse, such as the effect of waves or a sudden gust of wind. We thus see, by comparing the areas, C H X, H a M, H d m, and the small part of A e E above H M, the relative amounts of energy stored up in the ships when sailing at the given inclinations, and this energy it is which chiefly constitutes their safety. Comparisons may be made in the same way at any other angles of heel under sail.

It must be obvious from this that the danger to be apprehended to these monitors when under canvas is very great. And when we think that they are liable at any moment to be overtaken by sudden gusts of wind, and that, if they are heeled over beyond 8° or 10°, the farther they go the less resistance they offer to being capsized, their unfitness to carry sail must be quite evident.

If it should occur to any one to consider that the case of an ordinary barge is both an illustration and a refutation of the subject as I am here stating it, I would beg leave to remind him that the two cases differ in a most essential respect—the barge usually has nearly the whole weight both of her hull and of her cargo below the water, and therefore comparatively low down; whereas it is the object of these monitors to carry a large weight of armour, guns, and turrets mainly above water, so that the centre of gravity, the position of which is so important to the stability, cannot well be got low down. Any one who will take the trouble to closely compare the two cases will find that they differ exceedingly, and that, although barges sometimes carry a deck cargo, it is always of comparatively light material, and, when unbalanced by weights in the hold, leaves a considerable height of freeboard. And this leads me to observe that the state of the monitor which I have been describing would become very materially modified if the centre of gravity of the vessel could be greatly lowered, say to the extent of many feet; if, for example, it could be brought down to the depth of the centre of buoyancy, or beyond it. On reverting to fig 1, it will be seen that when the ship heels over in the direction of the arrow, the centre of buoyancy, C, also moves out in the same direction. This is the case, more or less, however low the freeboard. We also see that if the centre of gravity, G, of the ship is above C, the vertical line, G W, through G in the inclined position, also moves in the same direction. In other words, the vertical lines, G W and B M, both move outwards in the direction of the arrow; and we have seen that in the case of the monitors which we have been considering, owing to the low freeboard, B M moves slowly, so to speak, and is soon overtaken by G W, and the ship then capsizes. But if we suppose the centre of gravity to be below the centre of buoyancy, say at g, and draw the vertical line, $g\,w$, then it is obvious that, as the ship is inclined, B M and $g\,w$ move off from the middle line in opposite directions, and the distance between them, and consequently the statical stability, increases as the ship heels over. This case no doubt corresponds to that of the sailing barges loaded deep with hold cargoes before referred to; and it is a good illustration of the fact that vessels which may seem to a casual observer alike in principle, may, nevertheless, be seen by the naval architect to possess totally opposite qualities.

A very little reflection will suffice to show that we cannot, as a rule, avail ourselves of this last exhibited principle in the construction of armoured monitors. The tendency of things is to increase the upper weights, that is to say, the weights of the deck, the turrets, and the guns, and to lighten the construction of the hull below water as much as possible; and although the resort to great engine power and coal supply would tend to correct this tendency and to lower the centre of gravity, it is extremely improbable that in future iron-built ships we shall ever have a very low centre of gravity associated with the monitor type of vessel.

I do not, however, wish to use the present paper as a bar to future developments of the monitor system; its sole object is to show that monitors having their centres of gravity situated approximately like the centres of gravity of other ships would be quite unfit to carry a press of canvas.

Fig. 6.

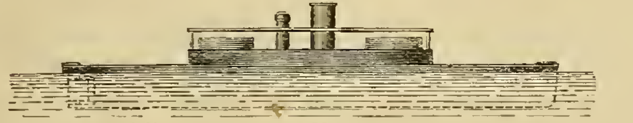


Fig. 7.

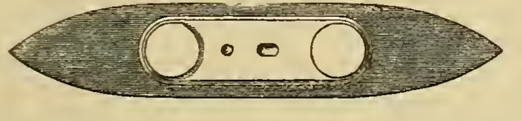
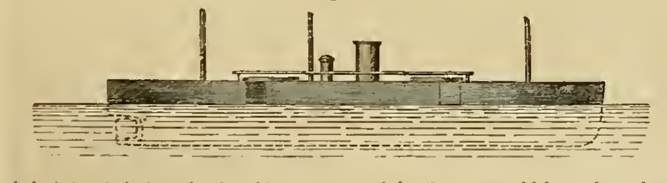


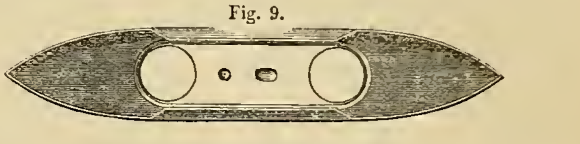
Fig. 8.



Before closing this paper I may make a few observations on the behaviour of these monitors as influenced by wave motion. I have already referred to the fact that the steadiness at sea of some of our ironclads is due to their want of stiffness or stability, and consequent increased time of oscillation in still water; and, I may add, that it is a very well-established fact that ships which have great stiffness in still water are very uneasy rollers. Now, it will be seen that these monitors converted from line-of-battle ships, as before mentioned, have great stiffness for small angles of inclination, and they would consequently start rolling under the same influences as ordinary ships which are very stiff and have a freeboard. This would, but for another consideration, be a very dangerous feature in the monitors, because it would cause them to roll quickly until the range of roll became large, and they would then get into positions where their stabilities would be small and decreasing, and from which if under canvas they might not be able to right themselves. Suppose, for instance, a ship of this kind rolling among waves of the same periodic time as her small oscillations. Should she roll beyond her position of maximum stability she would have her time of roll increased, and the following circumstances would then occur:—When reaching the hollow she would not have finished her oscillation, and might be still rolling towards the approaching wave; the alteration of the direction of the water surface caused by the front of the approaching wave—instead of developing in the ship a greater moment of stability tending to right her, as is the case with all ships which have a high freeboard—would diminish what stability there was remaining, and the danger of her being blown over, if she carried sail, would be very great. The stability of these ships, in fact, would appear to vary in the worst manner possible for safety. They would have all the characteristics of very uneasy ships until they rolled deeply, and not have the advantage of an increasing stability to prevent their rolling too far. The consideration which modifies this state of things materially is, that the very absence of freeboard which deprives them of the necessary stability at great inclinations would usually operate in the early stages of rolling to mitigate the impulses which the waves impress. And besides this the amplitude of rolling is undoubtedly much diminished by the disturbance of the water, which the immersed angle between the deck and the side causes, and is still farther diminished by the plan adopted in America of allowing the armour and backing to project from the side, instead of their being imbedded in the side, as proposed in the cases which we have been considering. In fact, this projection of the armour beyond the side must play an important part in the alleged steadiness of the American monitors. Its action is like that of an immense bilge keel, and is very effective in diminishing the angle of roll. For instance, if a ship of the form of fig. 5 were set rolling, the resistance caused by the action of the projection at A on the surrounding water would be very great, and would tend to diminish the amplitude of roll. The action of the angle, B, when immersed would be of the same kind in all monitors, whether the armour projected or not, and would be as follows:—If the ship were rolling towards the side, A B, the angle, B, would have very little effect on the amplitude of roll, but as soon as the ship commenced to return to the upright it would act to prevent her, and thus tend to increase her time of roll; and by diminishing the force with which she returns to the upright would indirectly tend to decrease the amplitude of the next roll. It will then be seen that the action on the water by the angle at A is always in the right direction, while the action of the angle at B may be acting against the ship when she is in the most critical positions, viz., when she has rolled over to an inclination where her stability is very small—and with decks as low as the American monitors this would be the case at very moderate angles of roll—so that by losing A while retaining B, which we do if we put the armour in a recessed side, we give up a really valuable feature while we retain one which, under certain circumstances, may prove a disadvantage. I need hardly add that I am here speaking only of monitors which have to serve at sea, and not at all of mere harbour defence ships.

I have recently had occasion to consider two other cases of a somewhat similar kind. We are building for the government at Melbourne an ironclad monitor with a height of deck above the water of 3 feet, and with an armour-plated breastwork surrounding the bases of the turrets, and inclosing the hatchways, as in figs. 6 and 7. This monitor has to be navigated to Melbourne, and for this purpose is to be fitted with a temporary side and upper deck. I have shown in fig. 2, by means of the curves, A F K and A F L, the variation of the stability of this vessel with different conditions of freeboard, observing that as this is a very much smaller vessel than the *Duncan*, the actual stability is very much less than in her case. The curve, A F K, shows how her stability would increase if the side were continued up as an ordinary ship, the whole length fore and aft. The curve, A F L, shows how it varies when the side runs up before and abaft the breastwork only, as in figs. 8 and 9. The difference between these two curves is caused by the break in the ship's side in wake of the breastwork, and shows how the stability is influenced by a departure of this kind from the usual continuous side. In neither case, however, have we that alarming decrease and loss of stability which the monitor proper would undoubtedly possess, especially with a very low freeboard.

Fig. 9.



In conclusion, I will only add that it will be no answer to the doctrines of this paper to say, that the rolling of ships is affected by the lateral distribution of weights, as well as by their vertical heights. This is undoubtedly true, and would deserve great weight in a discussion upon rolling. But my ruling argument is that the monitors we have considered would be dangerously deficient of statical stability, and this argument would hold equally with their weights either distributed or concentrated.

THE INSTITUTION OF CIVIL ENGINEERS.

March 31, 1868—The Paper read was, "The City Terminus Extension of the Charing Cross Railway," by Mr. John Wolfe Barry, M. Inst. C.E.

This line was authorized by Act of Parliament, dated June 28th, 1861, and the works comprised (1) a bridge over the river Thames, (2) the Cannon-street Station, and (3) viaducts south of the river, for connecting the bridge over the Thames with the main line of the Charing Cross Railway.

The bridge over the Thames had been constructed to carry five lines of way from the south abutment to the pier next to the Middlesex shore, at which point the five lines branched out, and were connected with nine lines of way in the station. There were two footpaths, one on each side of the bridge, intended for the use of the public on payment of a small toll, but they had not yet been opened for traffic. The extreme length of the bridge between the abutments was 706 feet. This length was divided into five spans, the two side openings being each 125 feet, and the three centre openings being each 136 feet in the clear on the centre line. The width of the straight portion of the bridge outside the footway parapets was 80 feet, and the width of the railway portion between the inside parapets was 61 feet 8 inches. The fan, which extended over the Middlesex opening, was widened out to 202 feet at the abutment, and accommodated, in addition to the lines of way, portions of two passenger platforms, engine sidings, foreman's offices, &c. The height of the soffit of the bridge above Trinity high-water level varied from 24 feet 8 inches at the abutment to 25 feet 4 inches in the centre span. The object of this arrangement was to prevent the bridge appearing depressed at the centre. The height of the rails above the soffit of the bridge was 9 feet 10 inches.

The southern abutment was built on cast-iron caissons, sunk side by side, partly by means of divers working in helmets, and partly by dredging inside the caissons with a bag and spoon dredger. In the case of the north abutment, neither caissons nor cofferdams were used; short lengths of ground were excavated at low water, a small "stank" dam of clay was employed, and the water being pumped out as the tide ebbed, the excavation was continued and the footings were got in. The piers were each formed of four cast-iron cylinders, placed in a line at right angles to the longitudinal axis of the bridge, and connected by two wrought-iron transverse girders at the top. The outside diameter of the cylinders was 18 feet below and 12 feet above the bed of the river; a conical reducing ring being introduced to effect the junction between the two diameters. The cylinder plates were fluted from 5 feet below Trinity high-water mark up to the level of the ornamental cap mouldings. In sinking the cylinders, the bed of the river was first smoothed by dredging; then the two bottom rings, together 13½ feet in height, which was equivalent to the greatest depth of water at low tide, were put together on timbers, between strong timber guides, exactly over their destined position. This portion of the cylinder was next raised by a travelling crane so as to permit the removal of the supporting timbers, and was afterwards lowered into position. A third ring of plates was then added, and a bag and spoon dredger was employed inside the cylinder, to take out the mud and gravel. As the cylinder descended additional rings were bolted on until the London clay was reached, when the sinking was continued by ordinary excavation until the final depth was attained, which was from 59 feet to 65½ feet below Trinity high-water mark. The cylinders were filled with Portland cement concrete up to the level of the bottom of the reducing ring, and on this brickwork, also in Portland cement, was carefully built for the full height of each column, being capped with large bed stones 2 feet thick. Each of the cylinders was weighted at the testing line with 850 tons of iron. This weight was calculated to represent the dead weight of the structure above that line, a rolling load of 1 ton per lineal foot for each line of way supported by the cylinder, and a moving load on the footpaths. The order to remove the load was not given until it was ascertained that no subsidence had taken place for seven days. The greatest subsidence under the full test load was $2\frac{5}{8}$ inches, and the least $\frac{1}{8}$ inch. The heaviest weight on the London clay at the bottom of any of the cylinders was 5·84 tons per superficial foot, with a rolling load as stated; and the heaviest weight on the brickwork in the cylinders was about 9 tons per superficial foot.

The particulars were next given in detail of the bed-plate girders, of the outside main girders, and of the intermediate main girders. The girders for the two side openings were independent of the other spans, but those for the three centre spans were continuous over the three openings. The flooring of the bridge was composed of flat plates of wrought iron $\frac{1}{2}$ inch thick, which were rivetted to the top flanges of the main girders, and were further strengthened by angle or T irons; for as the floor of the bridge formed the station yard, and was occupied by cross roads, as well as by the through lines, it was necessary that it should be capable of carrying the rolling load in any direction. Upon the flooring plates asphalte was laid, which was covered with an average thickness of 5 inches of ashes, as ballast, and on this the ordinary permanent way was placed.

The piers of the bridge, from the bottom of the cylinders to the bed-plate girder, contained in all about 2500 tons of cast and wrought iron. The superstructure contained about 4200 tons of wrought iron in girders, floor-plates, &c., and about 1100 tons of ornamental castings. The cost of the Cannon Street Bridge, including the abutments, signal bridge, and all things connected with the work, with the exception of the permanent way, signals and signal apparatus, gas and water mains, amounted to £193,000. This sum gave £2 15*s.* as the cost per superficial foot, and £250 per lineal foot, or £50 per lineal foot for each line of way, including the fan and footpaths.

The length of ground occupied by the Cannon Street Station, between the river Thames and Cannon Street, was 855 feet, distributed as follows:—The forecourt was 90 feet wide, the booking offices were 85 feet wide, and the length of the covered portion of the station south of the booking offices was 680 feet. The width of the station outside the walls was 202 feet, and inside the walls, at the platform level, it was 187 feet. The whole of the station was built on a substructure of brick piers and arches, excepting the booking offices and the part which was over Upper Thames Street. At the crossing of this street, which passed underneath the station at about midway of its length, wrought-iron girders were used. Openings were left in all the piers, to allow tramways to be worked throughout the basement if necessary; and provision had been made in the arches for an hydraulic lift to raise and lower the waggons. The cross openings north of Upper Thames Street were mostly carried up through the springing of the large arch, and were groined into it. The groining, which was 27 inches thick, was built in Portland cement, and the keystone was of Bramley Fall. It was adopted in consequence of the height of the ground not allowing communication between the different main archways, by transverse arches below the springing of the large arch. Without intercommunication the value of the vaults would have been commercially much diminished, and they would not have been available, as they were now, for parcels offices, stores, and railway purposes. The station walls were almost entirely of brickwork in mortar—the only exceptions being the arch over Upper Thames Street, and a few courses at the top of the walls, which were laid in cement.

The main trusses of the roof consisted of segmental ribs with a tie-bar looped up. The clear span of the trusses was 190 feet 4 inches. The rise of the rib at the centre was 60 feet, and the rise of the tie-bar was 30 feet. The truss was, therefore, 30 feet deep at the centre. The particulars of the different members were then given in detail. The ordinary distance from centre to centre of the trusses was 33 feet 6 inches, being the same as the distance between the centres of the piers of the substructure. In crossing Upper Thames Street, however, the distance apart was increased to 35 feet $1\frac{1}{2}$ inch, in order to suit the abutments of the bridge over that street. The weight of a single truss was $47\frac{1}{4}$ tons. The parts of the roof not glazed were covered partly with zinc and partly with slating. A lantern, 22 feet wide, extending nearly the whole length of the roof, was glazed on the top, and had the sides fitted with louvres, which afforded means of ventilation. Two movable timber stages, designed by Mr. J. Philips (Assoc. Inst. C.E), were used in the erection of the roof. One was as high as the top of the segmental ribs, and was employed in the erection of the trusses; the other was smaller, being low enough to pass under the tie-bar, and was used for painting, glazing, and finishing. The cost of the roof of the Cannon Street Station had amounted to £49. 10*s.* per square of 100 superficial feet of area covered, measured between the walls. The cost of the roof of the Charing Cross Station was £39 per square. In both instances the price of iron was high, the contract price for wrought iron in place in the roof being £24 5*s.* per ton.

The booking offices, waiting rooms, refreshment rooms, &c., were at the north end, at right angles to the lines of way, and were chiefly situated on the ground floor of the building which, above and below them, formed the City Terminus Hotel.

The parcels offices, stores, cellarage, &c., were in the basement of the station, access from the rail level being given by means of stairs; while hydraulic lifts were provided for raising and lowering the parcel trollies. There were nine lines of way in the station, of which eight lines were alongside platforms, one line being set apart for spare stock and standing room. The eastern and western platforms were each $13\frac{1}{2}$ feet wide at the centre, the general departure platform was 19 feet wide, and the general arrival platforms were $12\frac{1}{2}$ feet wide opposite the cab road, and about 30 feet wide beyond. The principle of having a line of railway on each side of the platform, instead of a platform on each side of a line, was believed to be the most economical in space, and, relative to the space occupied, the most economical in working. The area of the platforms which were alongside trains was 43,877 superficial feet, and the length of the trains accommodated was 4778 lineal feet, giving about 9 superficial feet of platform for each lineal foot of train.

The station-yard and signals were then described; and it was stated that the arrangement adopted was, that every line should approach every platform without back-shunting, excepting only the platform on the western side, which was to a great extent devoted to the short traffic to and from Charing Cross. This principle had been carried out by means of about forty pairs of points. The signal-box was 42 feet long by 9 feet wide; there were four posts, with twenty-four semaphore arms, eight arms being for "out" trains, and sixteen for "in" trains. The signal-box contained sixty-seven levers, of which thirty-seven worked signals, and thirty worked points. The signals locked the points and each other, so that no contradictory signals could be given; nor could the permission for ingress to or egress from any platform be given, until the points were arranged in accordance with the signal for that particular platform. An idea of the duty performed by this apparatus, which was erected by Messrs. Saxby and Farmer, might be formed from the fact, that seven hundred and seventy-five trains had passed under the signal bridge in a single working day. One morning, lately, thirty-five trains were signalled and passed in or out of the station in thirty-five minutes. Mr. Walker's electric telegraph apparatus, which worked a miniature semaphore distance-signal in each box, was used for signalling the trains on the block system.

The cost of the works of the City Terminus Extension was £505,336. and of the whole Charing Cross Railway, including the extension, £1,160,118, or including land, somewhat more than three million sterling. In this sum, it was to be remembered, were included about $4\frac{1}{2}$ miles of railway for a double line, two large bridges over the river Thames, a considerable number of expensive street bridges, and two of the most extensive metropolitan termini. The importance of the traffic, which was not at present fully developed, might be gathered from the fact that during the year ending the 1st of January, 1868, being the first year since the City Terminus Extension Railway was opened, about eight million passengers used the Cannon Street Station, of which number about three-million and a half were local passengers between Cannon Street and Charing Cross. At the present time about twenty-six thousand passengers used the Cannon Street Station daily, and the South Eastern Railway now conveyed about fifteen million passengers annually.

MONTHLY NOTES.

Brief Notes on the Mutations of Imponderable Elements, by J. C. Dyer, Esq.—In the history of speculative science we have seen a great many learned and ingenious theories to account for the varied phenomena presented by the elements that evade the direct tests of weight and measure—such as light, electricity, and magnetism, and more especially that called heat or caloric. With respect to the nature of the latter, directly conflicting views have been taken by philosophers of eminence, both ancient and modern, in expounding the causes of calorific phenomena; on the one hand denying, and on the other affirming, the identity or reality of heat as a natural element. Among the ancient asserters of the nonentity doctrine, we find the names of Boyle and his followers; and in modern times those of Count Rumford, Sir Humphry Davy, Dr. Joule, and many others of less eminence: and in support of the material nature of heat, we have the names of Boerhaave and his school, and in later times those of Dr. Black, James Watt, Sir James Leslie, Dr. Hutton, Dr. William Henry, and Dr. Dalton, with others of note. Without here discussing the diverse grounds of difference on the questions at issue (having elsewhere dwelt at length on their respective bearings), I proceed to explain those on which the materiality of heat appears to rest, and whereon the entire range of phenomena connected with the imponderable elements may admit of rational solutions. I assume the existence of four distinct states or conditions of heat, and which are thus defined, viz.:—(1) Elemental or neutral heat, (2) latent or combined heat, (3) sensible or expanding heat, and (4) radiating heat. Of the two last forms little need be said beyond what is directly seen in their alternate changes into and out of the other forms of heat (explained further on). The existence of a pervading medium in space has been admitted by the most eminent physicists; but no explanations are given of its nature, except that of its elasticity, nor yet of what are the relations of this medium to those of light, heat, electricity, and magnetism. It is treated as a pervading "ether," or "luminous ether," and its resistance to the transit of light through space has been estimated and given in figures by a profound philosopher, who, in treating of the undulations of light, describes it as "an elastic medium pervading all space, not even excepting what is occupied by what we call material bodies, that is, such as have weight, and which to us constitute the visible and tangible universe of things." (Sir John Herschel, Bart., "On Light," in *Good Words* for July, 1865.) In the works of Boerhaave the said medium is described as "a calorific element, *sui generis*, pervading all space and all bodies, and being in itself of the nature of fire." Thus "a pervading element" rests on very high authority, both ancient and modern; and it is of the nature of such element, and its agency in natural phenomena, that I propose to treat, and to show that the different forms of imponderable matter, as light, heat, electricity, and magnetism, are all essentially identical, and in proof of this we must look to their reciprocal interchanges with each other, whereby their common origin, in one pervading element, will be made probable, if not a physical certainty. The term formerly applied to this pervading element was a "calid" or "calorific" element, thus conveying the idea of active fire or very great heat; but they do not accord with the nature or properties which I ascribe to such pervading element, that of "neutral or elemental heat;" and the term latterly employed to indicate the same element is also inapplicable, since it only points to one of its properties, viz., elasticity. I have, therefore, adopted the term of "neutral heat," which is meant to convey the idea or notion that this element, in fact, constitutes the source, or fountain, whence all other forms of heat are derived, and into which they alternately return. This neutral element is everywhere of equal density, by reason of its elastic tension, and it therefore cannot exert or possess the force of gravity or of inertia, and it must remain in a quiescent state, except in cases where its equilibrium becomes disturbed by external forces, mechanical or chemical, as after mentioned. Let us consider the nature of these forces, and, first, the vast mechanical forces continually acting upon this medium by the earth's orbital passage through it. As the earth advances, her force will compress the medium in front of her path, but its equilibrium must be instantly restored by its reaction in her wake. This reaction explains the slight retarding force of the medium on the periodic motions of the planets. Now, the disturbing forces of these orbital movements, along with the axial rotation of the earth, serve to generate continuous currents in the medium, and which constitute what we call magnetism, or the magnetic currents, such as flow from the central action in the earth's path towards the north and south poles. In addition to the invisible currents, shown by the magnetic phenomena, we may fairly assume that this mechanical action of the earth generates those luminous currents in the medium that are known, at certain seasons, as ground lightning, and at others as auroras or coruscations of polar lights. We have next to consider the frictional action of the surfaces of the sun and earth upon that portion of the medium which extends in a right line between the sun and the earth, and which, acting at the ends of the intervening column, excites the medium into those undulations or vibrations that act on our senses, and give the impression of white light when seen through clear air, and of coloured light when the undulations are disturbed by clouds or vapours. But, to receive the impressions, we must be within the intervening column, or near it, as in twilight. Now, although this medium is only perceptible as light, yet the medium itself is at all times present, equally in the night and in dark rooms as in daylight; for when its action as light is cut off by opaque bodies, still the ambient element continues to act on our feelings and bodies as sensible heat, and this in different degrees of temperature, and when the heat is intense it becomes visible as red, or white heat and light. The duplex nature of light, too, is shown by the action of the prism; in the spectrum, where an increase of heat appears by moving the thermometer from the lightest to the darkest or red rays, and a still higher temperature is shown when the bulb is placed just outside of the visible spectrum, viz., in the dark rays; thus clearly proving that, by this mechanical action on transmitted light among the visible rays, it is partially converted into heat, and wholly so converted outside of the spectrum or in the dark rays. We find also that sensible heat obeys the same laws of reflection and refraction that govern the motions of light, and differs only in the transmission through opaque or transparent bodies. Besides, we see the mechanical action of the lens gives direct proof of the conversion of light into heat by the simple convergence of its rays upon a point, whereby intense heat is produced. The plain inference, then, is that an element thus alternately exhibiting both the mingled and separate phenomena of light and heat must possess identical properties, and that those several conditions of it are to be ascribed to the mutations of one element when subjected to the said acting forces. The facts adduced are clearly explained on this assumption, viz., of the identity of light and heat, whilst they present a strange mass of anomalies if viewed as produced by the movements of two distinct elements in space. I pass from mechanical action to consider the chemical forces, continually acting on and by this medium, whereby its mutations are effected, and among these, the most extensive are caused by the affinities between heat and water, as shown in common surface evaporation. Without here dwelling upon the diverse doctrines or views of late entertained respecting the nature of latent or specific heat, it will suffice to state the following facts, viz., that 212° of sensible heat are required to raise water to the boiling point, under the atmosphere, and then to convert the water into steam, 940° more sensible heat, are absorbed. This latter disappears, as sensible heat (call it latent, specific, or otherwise), but when the steam is condensed and returns to water, then the same 940° reappears as sensible heat. Now we all know that such absorption and redischarge of heat is continually taking place, in the evaporation from the earth's surface, by the action of solar heat. This heat, then, to the extent at least of 940°, becomes latent in the steam, or invisible aqueous vapour, at the surface, and the same heat is again given out in the upper air, where the vapour is condensed into clouds or fogs. The experiments and estimates of Dr. Halley enable us in some degree to perceive the stupendous scale of the daily ascent of water in vapour,* into the higher regions of the air, when its heat, both sensible and latent, is evolved. But this heat does not thence return to the earth as sensible heat, because the temperature above the clouds is always at or near the freezing point. What, then, becomes of these vast floods of sensible heat that enter the vapour at the surface and entirely disappear in those cold regions above? The plain answer seems to be that the entire heat, so ascending and disappearing, simply passes into its normal or elemental form of neutral heat. On this view of the mutations of heat, we see why it must become more or less redundant in the upper air, according to the varying rates of evaporation. These mutations of heat will account for its becoming redundant, or of higher elastic tension, as a neutral element in the upper air, and comparatively deficient near the earth, whereby the balance of tension, or its equilibrium, must become more or less disturbed, according as evaporation varies at the surface. In this way such continuous fluxions of heat into the higher regions, and its redundant state there, generates and sustains the return currents of the element from above towards the lower clouds and the earth, which elemental movements constitute the electrical currents, such as are shown by electrometers. The diurnal variations of these currents arise from the differing rates of evaporation in the day and night. The ordinary course of these elemental fluxions apply to the common invisible currents; but in like manner, when the mutations are excessive, they will account for the more rapid and violent electrical phenomena, constituting the thunder storms and lightnings which so often occur within the tropics, and sometimes in our latitudes when evaporation is very rapid.† In fine, all of the coruscations, or vivid transits of the said element to restore its disturbed equilibrium, are to be taken as constituting what we call the electrical and magnetic currents, as before said. Since we find that mechanical forces are exerted, as in telegraphy, &c., both by the electrical and magnetic currents, their materiality is clearly proved, for such action can only be by contact of natural bodies; and by conjoint action they are shown to be merely two conditions of one and the same element, just as the mingled and alternate action of light and heat show them to be but two forms of one element. The amounts of latent heat in different bodies may be here passed by; but one other case of latent heat in aqueous vapour should be noticed, viz., the heat evolved in respiration. Beneficent nature always provides for her own wants in excess. The carbonic acid formed in the lungs gives out the needful heat to keep up the temperature of the warm-blooded animals, and the excess of heat so evolved is taken up by the water converted into steam, and which is carried away in breathing. Now, if the whole of the heat so absorbed in the steam were to remain as sensible heat in it, the 940° held latent therein would at once produce a temperature quite destructive of the living textures, and would of course extinguish life. Thus we see another of the sublime laws of Providence is made to rest on these mutations of the imponderable elements. Little need here be said concerning radiating heat as apart from that of light, yet one instance may be cited, viz., the experiment of suspending a thermometer from the top of a glass-receiver on the table of an air-pump, then by rapidly drawing out the air the temperature will fall to or near the freezing point, but the mercury will again slowly rise till it reaches the temperature of the room; but as the thermometer (attached by a non-conductor of heat) is quite isolated in a vacuum, how can the heat reach and re-enter the bulb, except it be by radiating from the external warm air through the glass and the vacuum, and thus restoring the equal temperature inside and outside of the receiver? This process is of the same kind as that of heat radiating from a common fire-place to warm a room. In my "Notes on Heat in Relation to Atmospherical Phenomena," read at the Society, February 9th, 1853, besides adducing reason for assuming that all electrical and magnetical phenomena are simple consequences of the mutations of one pervading element, I have therein shown how most of the great aerial and oceanic currents may be traced to the acting forces generated by the mutations of heat, when they are excited in conjunction with those of gravity. Now, since all philosophers recognize the presence everywhere of the three elements of light, electricity, and magnetism, as also the fact of their reciprocal interchanges of form, as exhibited in phenomena; and as we find, also, the general admission of "an elastic ether" in space; it would seem far more in harmony with the "simplicity of nature's laws" to ascribe those known forms of "the imponderable elements" to the mutations of one than to the existence, in space, of four distinct elements. I have accordingly aimed to show that each of the known conditions of imponderable matter are traceable to the mutations of the one pervading element, and, for the reasons before stated, I call this elemental or neutral heat.—*Manchester Philosophical Society.*

Statue of Palissy the Potter.—The inauguration of a statue of Bernard Palissy is to take place at Saintes, where the famous potter was born, on the 3rd of this month. The *fête* to be given on the occasion will recall one of the most interesting events in the history of the town, namely, the entry of Charles IX. and Catherine de Medicis, and their visit to Palissy, whom they took with them to Paris, where he was installed in the old Louvre, and executed some remarkable works; and where the remains of his kiln and a number of his moulds were discovered last year.

The Decimal System in Germany.—For years the decimal system has been talked about, written about, publicly spoken about, and lectures delivered respecting its merits and demerits, until one has almost forgotten what the term precisely implies. The subject is, we believe, at present in the hands of a committee, where it will probably remain for a long time to come. Other continental nations are engaged in a similar investigation, and we are inclined to predict that they will finally solve the question for themselves before we have got through the first stage. About three weeks ago a scheme was laid before the federal council in Germany, advocating the adoption of a decimal system, and backing its arguments by twenty-three principal clauses, many of which are subdivided into an equal number of secondary ones. The substance of it is very similar to that projected by the old Germanic Diet in 1865, but it varies slightly in its details. As might be anticipated, the base of the system is the metre, and it exhibits a close analogy to the French system. The standard of length is a platinum bar, and that of weight a kilogramme of the same metal. The scheme provides for the regulation of lineal, superficial, and volumetric standards. The superficial measures are obtained by squaring those belonging to the lineal, and are called arcs. An arc equals 100 square metres; the hectare equals 100 arcs, or 10,000 square metres. The volumetric standards are obtained by cubing the lineal measures, and commence with the litre. Taking the metre to equal unity, we shall have the litre equal to a cubic decimetre $= (0{\cdot}1)^3 =$ the $\frac{1}{1000}$ of a cubic metre, or, algebraically, $(0{\cdot}1)^3 = \frac{1^3}{1000}$. Similarly the hectolitre equals 100 litres $= \frac{1^3}{10}$. The "toise" and the "corde" will each equal 2 metres; the verge, 5 metres; and the mile 7500 metres. An acre will contain 2500 square metres, or the fourth part of a hectare; and the plafter will contain four cube units. The ordinary pound will be divided into 500 parts with decimal subdivisions. Representing the pound as unity the gramme will equal $\frac{1}{500}$, the ounce will be equivalent to $\frac{1}{10}$, and the Prussian quint will have the value of $\frac{1}{100}$. All the subdivisions of the gramme will be in accordance with those adopted in the French nomenclature. What we term "troy weight" will remain as it was authorized in the German session of 1857. Whatever may be the exact English decimal system, it will in all probability bear some resemblance to that we have described, for the base of them all is the French system, and to that all must bear more or less similitude.

The Suez Canal.—In a recent number of the *Revue Contemporaine* will be found an article by M. Amedéc Marhean, in which he examines the advantages and drawbacks the passage of the Suez Canal may offer. If distance only were taken into account there could be no question about it; but, unfortunately, there are meteorological considerations which render the new route difficult for sailing vessels. The winds of the Mediterranean and Red Sea, though favourable from March to October, will be the contrary during the winter season, for the out passage to India. The opposite will be the case for home-bound vessels. It has been calculated that at present the average time required for the Cape of Good Hope, starting for Cape Lizard, is in the summer 106 days for Ceylon; 107 days for Singapore; and 102 for the Straits of Sunda. By the Suez Canal these figures will be respectively 55, 77, and 70. But by doubling the Cape the vessel saves 10 francs per ton it would have had to pay in going by the canal, which, for a ship of 650 tons, makes a saving of 6500 francs. Now the daily expenses of a sailing vessel of that burden being 340 francs, the above sum would represent 19 days navigation, a difference to be taken into account in calculating the relative advantages of the two routes. It will be found that during the winter season the advantages offered by the out passage are, owing to the monsoon, much smaller than in the summer. For Java no time will be gained either way, and for Ceylon there will be an actual loss of 11 days by Suez. Nevertheless, deducting from the above 19 days, the vessels going by the shorter route will still have arrived a week sooner than those which have doubled the Cape, and will be able to forestall the competitors in the market, if, as is usually the case, that be an object. But if, instead of a sailing vessel, the craft be a mixed one, say of 1600 tons, matters will assume a different aspect. The voyage by the Cape will be 77, 75, and 71 days respectively. By the Canal, 43, 54, and 53; the 16,000 francs for the tonnage dues will only represent 16 days' navigation at the rate of 1000 francs per day, so that whether in winter or summer such a ship will always be a gainer by taking the Suez route.

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* Dr. Halley (in the Philosophical Transactions) "has shown that more than five thousand millions of tons of water ascend in vapour daily from the surface of the Mediterranean only." Now it follows that a mighty force must be exerted in raising this stupendous weight of water (to the height of some thousand feet) against the force of gravity in the water, and the elastic force of pressure by the air. But this evaporating force is solely due "to the known relations of heat and water," and is (as before said) a chemical force.

† "The phenomena of aqueous meteors, such as rain, fog, and dew, depend upon the known relations of heat and water; electricity appears to be a consequent, rather than an agent, in the formation and decomposition of clouds, or if a necessary agent, it is equally so in the boiling of water in our houses, or the drying of piece goods in a stove."—Dalton, *Memoirs Literary and Philosophical Society*, vol. iv. 2nd series, p. 123.

THE COTTON MANUFACTURE IN SWITZERLAND.—One of the most important industries in Switzerland is the spinning and weaving of cotton. Spinning is chiefly carried on in the eastern part of Switzerland. The total number of spindles in all the establishments amounts to 1,600,000, of which 607,082 spindles are in seventy-eight establishments in the canton of Zurich; 266,805 in twenty-two establishments in the canton of Argovie; 200,000 in twelve establishments in the canton of Glarus; 172,136 in twenty establishments in the canton of S. Gallo; 109,800 in four establishments in the canton of Zug; 50,400 in Svitto; 42,800 in Turgovie; 31,600 in the Grisons; 30,000 in Bern; 22,768 in Soletta; 10,000 in the canton of Bâle; 16,120 in Scaffhausen; and 6016 in the canton of Lucern. The total number of workpeople employed in this manufacture is about 15,400, and adding the number of managers, the clerks, and other employés, and the families of the workpeople, about 30,000 persons may be said to depend on this industry for their livelihood. The annual production of the spinning mills in Switzerland is estimated at 338,630 quintals. In 1857 the exports of cotton yarn were 18,504 quintals against 4818 imports; in 1863, 53,836 quintals exports against 47,475 quintals imports; and in 1866, 35,738 quintals exports.

EXHIBITION OF INSECTS IN PARIS.—An exhibition of useful and destructive insects is announced to take place in the Palais de l'Industrie, under the patronage of the minister of Agriculture, during the month of August. It will be remembered that an exhibition of the same kind, on a small scale, was held in the same building in the year 1865, through the efforts of the Central Society of Apiculture; that first attempt gave rise to the formation of a new society of agricultural insectology, and it is this latter association which is entrusted with the organization of the coming exhibition. The committee includes Dr. Boisduval, M. H. Hamet, M. Guérin Méneville, M. Focillon, and several other entomologists and scientific agriculturists. The exhibition is to be made as comprehensive as possible, the scheme including the propagation of useful insects, methods of curing or preventing disease, and economical management; and the illustration of destructive insects, with means for opposing their ravages. It is desired that each class should, if possible, be exhibited in all its transformations, from the egg to the perfect insect, together with the matters on which it feeds. Printed or written memoirs are also to be admitted, even without specimens of the insects to which they refer. As regards destructive insects, the society has determined on a practical instead of a scientific classification, the subdivisions being formed by the plants upon which the creatures feed. Two additional divisions are added to the programme of the exhibition; one including carnivorous insects, and small mammiferous animals, such as the mole and hedgehog, which feed on insects; the other being devoted to the illustration of the ravages committed by snails and slugs. Some idea of what this amounts to in the vine growing districts of France, may be formed from the fact that thousands of bushels of snails are collected in the vineyards and sent to various markets all over the country; during the summer months the supply of this popular article of food is large and continuous all over France. As upon the former occasions, conferences on various subjects connected with insectology will take place in the exhibition. Foreigners are invited to take part in the coming exhibition, applications to be sent in before the 20th of July, to the secretary of the society, No. 1, Rue Cadette, Paris, or at the Palais de l'Industrie. The insects or other objects of exhibition are to be sent in before the 25th of July, and the exhibition opens on the 1st, and closes on the 31st of August. The following are the principal heads of classification:—First division—Useful insects: 1st class, Silk-producing insects. These will form the most important feature of the exhibition; the malady of the *gattine*, which has existed among the silkworms ever since 1848, is estimated to have caused a loss amounting to more than 60,000,000 francs, or nearly 2½ millions sterling per annum; 2nd class, Insects producing honey and wax; 3rd class Insects used in dyeing and for colour; 4th class, Edible insects, crustacea and molluscs; 5th class, Insects employed for medical use; 6th class: Insects used as ornaments. Second division—Destructive insects: Ten classes, viz., those which attack cereals, the vine, plants used in industry, forage, vegetables and ornamental plants, fruit trees, forest trees, timber used for building, truffles and fungi, dry organic matters, and, lastly, parasites of man and domestic animals. The third division includes three classes—carnivorous insects, parasitic insects, destructive of chrysalides, and insectivorous animals, birds and reptiles. The fourth division includes insects and other creatures destructive of molluscs; and notices respecting edible snails and the benefit that cultivators may derive from them. Lastly, optical instruments for entomological purposes, and special apparatus connected with the rearing or destruction of insects. Medals and honourable mentions will be awarded for the most remarkable objects exhibited.

TRIALS OF GUN VESSELS.—The trials of the screw gun-vessel *Staunch* commenced some weeks since on the Tyne, and have during the present week, 29th May, 1868, been resumed at Portsmouth. The results of the trials made on the Tyne are said to have been exceedingly favourable to the vessel, but they were conducted under somewhat lax regulations, and the more strictly official trials to which the vessel and her gun have been and are still being subjected supersede all previous trials. The *Staunch* is intended to carry out a principle, often advocated, one large gun on the smallest amount of tonnage that could be designed in the form of a floating steam-carriage. She is 79 feet in length only, with a beam of 25 feet; her deck 27 inches above the water-line amidships, when under steam, and with bulwarks of light iron of about 3 feet in depth. She is built of iron, with water-tight compartments, but is entirely unprotected by armour-plating. The one gun she carries is a 12½ ton 9-inch rifled muzzle-loader of the Elswick pattern and manufacture, with a double-sided iron carriage and slide, mounted on a square platform on the vessel's forecastle, or the foremost part of the deck. This platform is fitted at each corner with a screw box, which works on one of four columnar screws rising from the floor of the vessel's hold. The screws are driven by a donkey engine through gearing, and by this arrangement the platform with its gun, carriage, and slide can be lowered nearly below the level of the deck of the vessel whenever the latter may be steaming along the coast, or from port to port, and thus be carried with greater safety in a seaway. The bulwarks round the bows of the vessel and in front of the gun are built up some six or seven feet inboard of the vessel's stem. They are of light iron, proof to rifle-shot fire from boats, and sufficiently high to cover the gun's crew from any such fire from the front, but, of course, afford no protection against the fire from anything heavier than that of an ordinary rifle. Half-way upwards from the deck they are hinged so as to throw down so far outwards when the gun is brought into action. The small donkey engine that drives the screw gearing for raising and lowering the gun, also drives two small capstan heads which project above the deck on the right and left rear of the gun platform; side tackles brought to these capstan heads run the gun in and out. The training of the gun on the object to be fired at can be given by side tackles from these capstans through an arc of 40 deg., but the twin screws give a much superior means of training by making the vessel herself traverse the arc required, supplemented also as the screws are by the action of the rudder. The motive power of the vessel consists of a pair of engines of the collective nominal power of 25-horse, driving two three-bladed screws, each of 5 feet diameter and 7 feet pitch. Each engine has two cylinders of 14 inches diameter and 14 inches stroke, an air pump of 12 inches diameter and 7 inches stroke, worked from the crank shaft by a centrally fixed eccentric; one feed and one bilge pump, each 3 inches in diameter and 4 inches stroke, worked by back-gear eccentrics. One boiler supplies the engines with steam, as it does also the donkey engine for working the gun. It is fitted with two furnaces, and has a heating surface of 700 square feet. The *Staunch* has been designed by Mr. Rendell, C.E., of the firm of Sir William Armstrong and Company, of Newcastle-upon-Tyne, who also designed and constructed the small engine for raising and lowering the gun platform. The engines of the ship were designed and constructed by Messrs. R. Stephenson & Co. On Wednesday last the *Staunch* was taken out of Portsmouth harbour, under steam, and twenty-one rounds were fired from her gun—one blank and twenty with projectiles and full powder charges, the results, however, merely proving that the gun could be fired like all others of its kind. Some trials were also made with the platform raising and lowering gear, which were considered on the whole satisfactory. On Thursday the *Staunch* was again taken out of Portsmouth harbour, on this occasion to be put through her trial of speed over the measured mile in Stokes Bay, under the supervision of Captain W. C. Chamberlain, commanding her Majesty's ship *Asia* and the Steam Reserve at Portsmouth. The intended trial of speed was, however, abandoned, owing to the fact of a number of fire-bars having unexpectedly fallen out from the bottom of the furnaces. Some experiments were, however, made with the gun, in raising and lowering the platform, and in training the gun by the steam capstans and tackles only, which were not without interest, as bearing upon the real value of the vessel as a weapon of war. Steam was shut off from the main engine and applied to the small engine for raising and lowering the gun platform at 23 lbs. pressure. The gun, with all its belongings on the platform, was lowered first into the water-tight compartment built for it in the vessel's forehold in 6 minutes 45 seconds, and raised again in 9 minutes 33 seconds. Rope side tackles were afterwards fitted to the gun and brought to the steam capstan-heads on the right and left rear of the gun, and by these means she was run in or out as required with great quickness, the *maximum* time being 14 seconds, and the *minimum* 8 seconds. The attempts at training by the side tackles brought to the steam capstans was a failure, the platform appearing to require a very nice adjustment of level to the deck to enable the gun-slide to work freely. Further trials may place the *Staunch* in a more favourable light than she appears to have attained at present, her objectionable features being:—1, An unprotected hull, and liability to being sunk by a single shot; 2, Her low rate of speed under steam, estimated only at seven knots; 3, Her draught of water, being 7 feet aft, with all on board. The elaborate fittings for lowering and raising the gun platform appear superfluous. The gun can only be loaded when in position on deck, and as to lowering the gun into a part of the vessel's hold, to give the latter sea-going qualities when she is not intended for a sea-going craft, is simply ridiculous. If the *Staunch* has ever to steam from one port to another on the coast, she can lower her gun in the one port and receive a fresh one of the same kind in the other.

MOSCOW MUSEUM OF APPLIED ARTS.—The new Museum of the Fine Arts applied to Industry, established in the Strogonow School of Design of Moscow, was recently inaugurated. The general plan of the museum was drawn up by M. Boutowsky, on the basis of a plan drawn up for the Lyons Chamber of Commerce by M. Natalis Rondeau, which has been very generally approved. The museum is divided into three sections—Fine arts, Industry, and History; and it includes collections of flowers and plants remarkable for beauty of form or colour, collections of animals, birds, and insects; a cabinet of drawings and prints; a special library of illustrated works relating to the fine arts; decorations, ornaments, and architecture; and an atelier and workshop for the use of the pupils of the school and of the public.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

14th *May*, 1868.

1570 J. W. Wilson, Cavendish Square—Spring stuffing
1571 H. Marsden and T. H. Blamires, Huddersfield—Felted fabrics
1572 W. Gadd, Nottingham, and J. Moore, Manchester—Looms for weaving
1573 J. Ashford and W. H. Collins, Birmingham—Dress ornaments
1574 G. de S. Marie, Arcueil—Ornamenting capsules
1575 T. B. Kay, Bolton—Carding engines
1576 O. König, Watling Street—Album.—A com.
1577 J. Driver, Keighley—Effecting the consuming of smoke
1578 J. Dewar, Kirkcaldy—Preserving certain vegetable substances for use as food for animals
1579 J. E. Piper, Finsbury—Oil for lubricating machinery
1580 W. E. Newton, Chancery Lane—Felt hats.—A com.
1581 W. E. Newton, Chancery Lane—Steam engines.—A com.
1582 V. G. Bell, St. John's Wood—Locomotive engines and tenders
1583 W. A. Browne, Peckham; R. L. Jones, Edgware Road—Hand signal lamp
1584 N. Basevi, Torquay—Projectiles.—A com.
1585 E. Ashworth, Ramsbottom—Telescopic rollers
1586 W. Walker, Edinburgh—Cutting and dressing millstones
1587 T. G. Walker, Bonnington—Dressing stone
1588 W. R. Lake, Chancery Lane—Directing boxes and parcels.—A com.

15th *May*, 1868.

1589 T. J. Gathercole, Homerton, and T. R. Comyn, Hackney—Frames for umbrellas
1590 H. C. Crofts, Chatham—Bricks
1591 J. H. Johnson, Lincoln's Inn Fields—Hollow bricks—A com.
1592 J. H. Johnson, Lincoln's Inn Fields—Frames for containing photographs.—A com.
1593 J. Hicks, Kensington—Musical instruments
1594 F. Hyde, Hazel Grove—Bevel gearing
1595 T. Singleton, Over Darwen—Looms for weaving
1596 S. Chambers and C. Broadbent, Brightside—Preventing the radiation of heat from steam pipes
1597 A. Pelard, Paris—Portable hydrotherapic apparatus
1598 A. V. Newton, Chancery Lane—Liquid meters
1599 J. Robey, Newcastle-under-Lyne—Furnaces for consuming smoke
1600 W. and G. B. Smith, Kennington Park Road—Dry and wet gas meters
1601 A. M. Clark, Chancery Lane—Permanent way of railways.—A com.
1602 W. R. Lake, Chancery Lane—Embalming or preserving dead bodies
1603 J. Price, Dublin—Testing the durability and strength of rails

16th *May*, 1868.

1604 J. G. Tongue, Chancery Lane—Sewing or stitching together the numbers or separate parts of volumes
1605 W. Rule, Camborne—Dressing metallic ores
1606 H. J. H. King, J. Auchinvole, and A. Patrick, Glasgow—Gauges
1607 T. Briggs, Ripley—Signalling on railway trains
1608 A. J. Murray, Camberwell—Reaping machines
1609 R. Rayner, Lower Clapton—Cooking apparatus.—A com.
1610 A. M. Clark, Chancery Lane—Lamps.—A com.
1611 J. A. Adams, Edinburgh—Cooking ranges
1612 C. Golden, Bradford—Breech-loading guns
1613 W. Allday, Birmingham—Forge bellows
1614 A. Parkes, Birmingham—Manufacturing parkesine
1615 G. Price, Ryde—Musical instruments
1616 G. Smith, Leicester—Dies for pressing bricks
1617 W. E. Gedge, Wellington Street—Removing hair from hides.—A com.
1618 W. R. Lake, Chancery Lane—Iron and steel.—A com.
1619 M. A. Hamilton, Chancery Lane—Churns

18th *May*, 1868.

1620 J. W. Anderson, Glasgow—"Temples" for looms
1621 E. Billington, Reddish, and W. Jolley, Heaton Norris—Conveying steam through pipes—A com.
1622 W. Manwaring, Banbury—Mowing machines
1623 G. Watson, Commercial Road—Raising and lowering weights
1624 W. Needham and James Kite, Vauxhall—Preparing filtering surfaces for the depuration of fluids
1625 L. Goldstein, Bradford—Umbrella cloths
1626 J. F. Spencer, Sunderland—Steam engine valves
1627 A. M. Clark, Chancery Lane—Finishing linen fabrics
1628 J. Mitchell, Sheffield—Railway carriage springs
1629 J. Grantham, King's Arms Yard—Iron and steel built ships

19th *May*, 1868.

1630 E. P. H. Vaughan, Chancery Lane—Preparing anhydrous chlorides.—A com.
1631 E. P. H. Vaughan, Chancery Lane—Pipes for smoking.—A com.
1632 R. Pearce, Swansea—Separating copper and other metals from silver
1633 J. Flachfield, Basinghall Street—Cases for pipes.—A com.
1634 D. Riddell, Glasgow—Bread
1635 J. Steel, Glasgow—Cask-washing apparatus
1636 J. Elce, Manchester—Temples
1637 D. A. Cooper, Worcester—Solitaires for gloves
1638 J. Pollock, Birmingham—Drawing corks from bottles
1639 T. Griffin, Russell Square—Bleaching and cleansing fabrics

20th *May*, 1868.

1640 W. Jones and J. Hetherington, Manchester—Stretching woven fabrics
1641 H. H. Johnson, Cannon Street—Advertising in railway tunnels
1642 J. Kennet, Eastbourne—Ventilating sewers
1643 J. Fry, Marylebone—Folding perambulators
1644 R. Froehlich, Mildmay Park—Opening sardine and other sheet metal cases
1645 C. L. Taverdon and J. Moret, Paris—Lift and force double-action pump
1646 A. G. Hutchinson, Stoney Croft—Burglar detectors
1647 F. D. Nuttall, St. Helens—Reverberatory furnaces
1648 J. B. Whiteley, Lockwood—Stretching woven fabrics
1649 A. Bell, Alfred Road—Valves of steam engines
1650 J. F. Batho, Birmingham—Planing or shaping metals
1651 H. D. Hoskold, Cinderford, and J. Davies, Saint Whites, and G. P. Wheeler, Abinghall—Artificial fuel
1652 Z. Power, South Lambeth—Safety stopper for bottles
1653 A. Leslie, Turriff—Steam cultivation
1654 D. Jones, Hackney Road, and J. Jackson, Ratcliffe—Apparatus for heating the feet
1655 W. Tijou, Westminster—Steam pumps
1656 C. R. Havell, Reading—Water-heating apparatus
1657 W. England, Bristol—Measuring liquids
1658 A. V. Newton, Chancery Lane—Sewing machines.—A com.
1659 W. Inglis, Manchester—Steam engines
1660 W. Sim, Glasgow—Street-cleansing apparatus
1661 G. T. Bousfield, Brixton—Power looms.—A com.
1662 C. Barnard, Norwich—Chairs
1663 J. Couvers, Paris—Cranks, shafts, and axles
1664 W. R. Lake, Chancery Lane—Marking tucks on cloth.—A com.

21st *May*, 1868.

1665 C. Chapman, Hackney, and J. Lilley, London Street—Instruments for navigating ships
1666 W. Hammont, Pimlico—Aerial machines
1667 W. Palliser, Pall Mall, and T. J. Bolton, Rochester—Ordnance
1668 E. A. Chameroy, Paris—Gas meters
1669 W. Hadfield, Manchester—Looms for weaving
1670 J. E. Poynter, Glasgow—Soap
1671 J. Booth, Birmingham—Paper bag fastenings
1672 J. Crofts, R. Dawson, and J. King, Leeds—Combing wool
1673 E. E. Allen, Westminster—Packing materials in bundles
1674 S. Perry, Red Lion Square, B. J. B. Mills, Southampton Buildings, and F. Brompton, Birmingham—Letter clips
1675 T. G. Messenger, Loughborough—Double-action pumps
1676 J. Revill, Notting Hill—Self-acting revolving shutters
1677 R. Fryer, Manchester, and J. Fryer, London—Tilling land
1678 J. Starley, Coventry—Sewing machinery
1679 J. R. Batty, Leeds—Spinning flax
1680 W. E. Newton, Chancery Lane—Governors for steam engines.—A com.
1681 H. Hall and J. A. Mason, Burton-on-Trent—Propelling vessels
1682 F. E. B. Beaumont, London, and C. J. Appleby, Southwark—Drilling rocks for blasting
1683 J. W. Whittaker, Bolton-le-Moors—Carding engines
1684 R. Rayner, Lower Clapton—Frictional gearing.—A com.
1685 A. M. Clark, Chancery Lane—Cranes.—A com.

22nd *May*, 1868.

1686 C. Fusnot, Curighem-lez-Bruxelles—Central fire cartridges
1687 C. D. Abel, Chancery Lane—Drawing cop through shuttle holes.—A com.
1688 C. Mole, Farringdon Road—Boots
1689 W. E. Newton, Chancery Lane—Grate bars.—A com.
1690 C. J. Foster, Maldon—Reaping and mowing machines
1691 A. M. Clark, Chancery Lane—Rotary steam engines.—A com.
1692 J. Oury, Blois—Gas meter
1693 C. Delafield, Factory Ville—Furnaces
1694 R. K. Bowley, Rockhills—Floral devices.—A com.

23rd *May*, 1868.

1695 E. Jones, Bristol—Shadowless lamps.—A com.
1696 J. J. Harrop and W. Corbett, Manchester—Producing iron and steel from ores
1697 J. Higgins, Salford—Spinning cotton
1698 J. Fletcher, Bow—Revolving retorts
1699 E. W. de Rusett, Lewisham—Engines worked by steam
1700 T. Ashford, Birmingham—Gas tube hooks
1701 W. Leck, Clapham Road—Kilns
1702 J. S. Richard, Paris—Spinning machinery
1703 F. Werth, Frankfort-on-the-Maine—Causing the circulation of water in steam boilers.—A com.
1704 C. Windhausen and H. Bussing, Brunswick—Chimney cowls

25th *May*, 1868.

1705 T. J. Baker, Farndon—Wheat
1706 H. W. Everard, Manchester—Wearing apparel
1707 E. Hunt, Glasgow—Motive power
1708 T. Craig, Lincoln's Inn—Supporting windows
1709 P. Cameron, Glasgow—Ships' compasses
1710 F. Hargreaves and J. R. Collins, Bradford—Looms
1711 S. A. Smith, Walton-le-Dale—Carding engines
1712 A. M. Clark, Chancery Lane—Rotary engines.—A com.
1713 A. M. Clark, Chancery Lane—Motive power.—A com.
1714 H. Ferguson, Paddington, and A. Mulvey, Kilburn—Cutting tenons
1715 W. H. Kent, Knightsbridge—Fluting fabrics.—A com.
1716 W. W. R. and M. W. Johnson, Limehouse—Sheets of lead
1717 J. Scoffern, Finsbury—Treating paper
1718 J. E. Holmes, Ruabon—Cutting or dressing stone
1719 H. L. A. Lippens, Lille—Looms
1720 H. A. Dufrene, Paris—Railway wheels.—A com.
1721 W. R. Lake, Chancery Lane—Horses' harness.—A com.

26th *May*, 1868.

1722 J. Ferrabee, Stroud—Carding engines
1723 H. J. Bakewell, Devonport—Steering ships
1724 J. Adams, Cork—Cleansing casks
1725 C. E. Brooman, Fleet Street—Decolorizing tan
1726 J. A. Joyner and J. H. Jenkins, Liverpool—Screw propellers
1727 A. and C. Edmeston—Printing hanks
1728 A. S. Macrae, Liverpool—Removing ink from paper
1729 J. Morgan, Kidderminster—Ventilating hot-houses
1730 J. R. Williams, Liverpool—Printing and numbering
1731 T. Smedley, Holywell—Brakes for carriages
1732 W. E. Newton, Chancery Lane—Rotary engines.—A com.
1733 W. Buttery, Sheffield—Turning cartridges
1734 J. B. Miller, Hackney Road—Packing for steam engines
1735 W. E. Debenham, Haverstock Hill—Wrist bands
1736 B. Burton, Brooklyn—Breech-loading fire-arms
1737 W. R. Lake, Chancery Lane—Ploughs.—A com.
1738 W. B. Lord, Hampstead Heath—Portable filters
1739 W. Adkins, Birmingham—Stocks and dies
1740 A. M. Clark, Chancery Lane—Dressing millstones.—A com.
1741 F. Wirth, Frankfort-on-the-Maine—Governor for steam.—A com.

27th *May*, 1868.

1742 J. Dixon, Sheffield—Coupling link.—A com.
1743 H. A. Bonneville, Paris—Permanent way of railways.—A com.
1744 H. A. Bonneville, Paris—Breech-loading fire-arms.—A com.
1745 W. Cooper, Bradford—Sliver cans
1746 J. Morris, Liverpool—Facilitating the finishing of printed sheets of paper
1747 J. Vidie, Pantin—Ornamenting glass
1748 H. and G. Kearsley, Ripon—Mowing and reaping machines
1749 H. E. Mines, Cheltenham—Register stoves
1750 M. Gray, Highbury—Insulated conductors
1751 J. Scholl, Soho—Gas burners

28th *May*, 1868.

1752 J. Reidy, Kennington Park—Pick or pick axe
1753 H. and F. Bailey, East Retford—Valves
1754 R. Fell, Robinson Row, and R. Barlow, Shacklewell Lane—Preventing waste of water
1755 W. Dalziel, Deptford—Cock and valve for controlling the flow of water
1756 W. Alexander, Liverpool—Applying auxiliary power to sailing ships
1757 T. Drake, Huddersfield—Receiving communications
1758 F. Haudncoeur, Paris—Malaxating butter

1759 W. E. Newton, Chancery Lane—Horse rakes.—A com.
1760 W. E. Newton, Chancery Lane—Hopping beer.—A com.
1761 T. Greenwood, Leeds—Assorting the fibres of dressed silk.—A com.
1762 J. and J. B. Palmer, Bow—Matches and fusees.—A com.
1763 J. R. Hambling, East Dereham—Thrashing machines
1764 R. H. Bentham, Bedford Row—Facilitating the flow of liquids from barrels
1765 T. Shore, J. Eastwood, and W. W. Brealey, Hanley—Steam generators
1766 T. S. Horn, Newcastle-upon-Tyne—Miners' safety lamps
1767 H. Haines, Chancery Lane—Lead pipe.—A com.

29th May, 1868.

1768 F. N. Gisborne, West Strand—Signalling apparatus
1769 W. Maclean, Glasgow—Depicting designs on textile fabrics
1770 J. Turnbull, Edinburgh—Connecting and disconnecting carriages
1771 J. Drabble, Hasland, and J. S. Raworth, Manchester—Roll or twist tobacco
1772 H. Griffiths, Holloway, and F. A. Wishart, Ivy Cottage—Shearing the hair of horses
1773 J. B. Gardner, Kendal—Sifting pulverized tobacco
1774 E. Newton, Mount—Motive power
1775 J. Nuellens, Torquay, and M. Neuhaus, Strand—Cooling wine
1776 L. Hamel, Nottingham—Instruments for clipping lace
1777 G. T. Bonsfield, Brixton—Plating spoons.—A com.
1778 P. Buchan, Belfast—Hemp and flax

30th May, 1868.

1779 H. A. Bonneville, Paris—Sewing the edges of button-holes in cloth.—A com.
1780 A Smith, Glasgow—Sugar.—A com.
1781 R. Luthy, Bolton—Working hydrostatic presses
1782 T. Burrow and S. Keith, Glasgow—Weaving
1783 Sir J. B. Guest, Baronet, Wimborne—Cutting the edges of lawns
1784 J. Harman, Portman Square—Drawing-board
1785 H. Hirzel, Leipzig—Inflammable gas
1786 N. D. Spsrtsli, Liverpool—Consuming hydrocarbon oils in the furnaces of marine boilers
1787 J. B. Harris, Edinburgh—Pumps
1788 M. Chavsgnat, Paris—Closing and securing vessels
1789 R. Turner, Dublin—Umbrellas
1790 T. Field, Mauldslay—Manœuvring gunboats
1791 C. E. Brooman, Fleet Street—Central-fire cartridges.—A com.
1792 The Rev. O. Reynolds, Debach, Woolbridge—Steam ploughing
1793 W. R. Lake, Chancery Lane—Spirit levels.—A com.

1st June, 1868.

1794 S. Walker, Liverpool—Pocket time-keepers
1795 J. B. Farrar, Halifax—Spinning fibrous substances
1796 D. Jones, Inverness—Furnaces
1797 G. P. Reed, Boston—Watches
1798 R. W. Page, Chelsea—Hand garden engines
1799 C. D. Abel, Chancery Lane—Aluminous compounds.—A com.
1800 C. H. Wells, New York—Impregnating wood with oleaginous matters.—A com.

2nd June, 1868.

1801 E. P. H. Vaughan, Chancery Lane—Preventing incrustation in steam boilers.—A com.
1802 J. Tate, Bermondsey—Points for railways
1803 T. Christy, New York—Paper-staining machines
1804 J. Oakden and J. Pickin, Congleton—Enamelling iron
1805 J. Overy, Marylebone—Raising and lowering venetian blinds
1806 L. G. Mure, Paris—Fishing apparatus, termed a 'line carrier.'
1807 G. A. H. Lillie, Saint James'—Street Paving
1808 W. E. Newton, Chancery Lane—Lever escapements for watches.—A com.
1809 W. E. Newton, Chancery Lane—Cans.—A com.
1810 J. Law, Edinburgh—Instruments for drawing corks from bottles
1811 L. Sterne, Westminster—Driving belts
1812 F. Schäfer, Golden Square—Removing wax and dirt from the top of corks in bottles
1813 F. Roe, Notting Hill—Smoking pipes

3rd June, 1868.

1814 R. Soans, Stockton-on-Tees—Removing dirt and foreign matters from fruit
1815 A. Crestadoro, Chorlton-upon-Medlock—Navigating the air
1816 J. H. Johnson, Lincoln's Inn Fields—Pipe joints.—A com.
1817 J. H. Johnson, Lincoln's Inn Fields—Railway trucks.—A com.
1818 L. W. Wright, Brooklyn—Meters for water
1819 C. D. Abel, Chancery Lane—Iodine.—A com.
1820 H. J. Crockett, East Dalston—Venetian blinds
1821 J. H. Johnson, Lincoln's Inn Fields—Decorating walls.—A com.
1822 G. W. Reynolds, Stamford Street—Sewing machines
1823 E. Fairburn, Mirfield—Condensers for working wool
1824 W. E. Everitt, Birmingham—Tubes
1825 W. Pidding, Russell Square—Reels or receivers

4th June, 1868.

1826 W. Rye, Oldham—Supplying fuel
1827 D. Foster, Sheffield—Anvils
1828 G. Hartley and P. Robertshaw, Bradford—Steam boilers
1829 W. E. Gedge, Strand—Steam boilers.—A com.
1830 M. Rives, Paris—Ships' block
1831 C. E. Brooman, Fleet Street—Carbonic oxide.—A com.
1832 F. Schäfer, Golden Square—Appliance for holding a stick of sealing wax
1833 C. E. Brooman, Fleet Street—Transformation of iron and steel
1834 R. Woinar, Vienna—A tube of a metallic cartridge with central prime
1835 J. Ashton, Fleet Street—Horse shoes
1836 J. Worth and A. Barker, Rochdale—Covering rollers
1837 J. Petrie, junior, and J. Fielden, Rochdale—Hydraulic motive power
1838 N. Salamon, Ludgate Hill—Mounting photographic pictures.—A com.
1839 W. Firth, Burley Wood—Deodorizing petroleum and other oils

5th June, 1868.

1840 M. Theiler, Islington—Telegraphic instruments
1841 M. Henry, Fleet Street—Converting basic phosphates of lime into soluble acid phosphates of lime
1842 A. M. Clark, Chancery Lane—Combination locks.—A com.
1843 J. Page, Birmingham—Corkscrews
1844 C. D. Abel, Chancery Lane—Stopping motion for spinning machinery.—A com.
1845 H. A. Bonneville, Paris—Feeding sugar factories
1846 R. B. Sawers, Glasgow—Weaving ornamental fabrics
1847 T. C. Gregory, Glasgow—Springs
1848 F. Reddicliffe, Hendre Mine—Pump buckets
1849 A. Prince, Charing Cross—Metallurgical process
1850 W. J. Addis, Tanna—Carts
1851 O. T. Newton, North Egremont, and G. A. Newton, Liverpool—Steam boiler furnaces
1852 J. Wadsworth, Manchester—Composition suitable for the soles and heels of boots and shoes
1853 E. A. Dana, Brooklyn—Projectiles for rifled cannon
1854 R. Elsdon, Brockham, and A. Stein, Ryder Street—Glass
1855 A. Stephen, Middlesex Hospital—Ventilating buildings

6th June, 1868.

1856 J. Gerard, Tolton—Facilitating escape from fire
1857 A. Kerney, Middlesex—Preparing spun-silk waste
1858 M. Rae, Up Hall—Lamps
1859 H. A. Bonneville, Paris—Levelling and measuring distances
1860 J. Dewar, Kirkcaldy—Preserving and arresting decay in certain vegetable substances
1861 G. Maw, Benthall—Garden tallies
1862 A. V. Newton, Chancery Lane—Storing and measuring petroleum.—A com.
1863 S. Wilkerson, Chelmsford—Spreading manure
1864 G. Finnegan, Dublin—Band saw machines
1865 H. Reviere, Bayswater, and F. T. Baker, Fleet Street—Hand used for closing the ends of central-fire cartridges when loaded
1866 T. Metcalf and T. Longfellow, Shipley—Looms
1867 T. A. Weston, Birmingham—Raising and lowering heavy bodies
1868 J. Young, Kelly—Treating hydrocarbons
1869 W. Broughton, Finsbury Market—Kitchen ranges
1870 F. Waenzel, Vienna—Central-fire cartridges
1871 A. M. Clark, Chancery Lane—Forging.—A com.

8th June, 1868.

1872 G. Watson, Commercial Road, and W. I. and S. T. Baker—Artesian tube well
1873 S. Willets, Aston—Double-barrel breech-loading fire-arms
1874 D. Coffey, Newton Moor—Locks

9th June, 1868.

1875 W. Langan, Birmingham—Appertaining to steam boilers
1876 R. Husband, Manchester—Ventilating hats
1877 F. F. Benvenuti, Swansea—Inkstand
1878 J. Bourne, Regent's Park Road—Motive power
1879 J. S. Wilson, Poplar—Imparting rotary motion to mills
1880 T. D. Clare, Birmingham—Moulds for casting metallic articles
1881 R. B. Boyman, Clapham Park—Aerial navigation
1882 G. Howard, Oxford Street—Parquet flooring
1883 J. J. W, and D. S. Stafford, Nassington—Carriages used with apparatus
1884 A. Munro, Arbroath, and W. B. Adamson, Glasgow—Tools for hewing or cutting stone
1885 J. H. Johnson, Lincoln's Inn Fields—Oxide of Iron.—A com.

10th June, 1868.

1886 G. Davies, Lincoln's Inn—Lounging chairs.—A com.
1887 P. Fraye, Walbrook—Harmonium.—A com.
1888 W. Ferrie, Monkland Iron and Steel Works—Smelting blast furnaces
1889 J. T. Lsdyman, Rochdale—Working wood
1890 W. Hamer, Bowden, and J. Davies, Runcorn—Furnaces of salt pans
1891 J. Carter, Strand—Portable closet
1892 C. W. Siemens, Westminster—Cast steel
1893 J. and E. Firth, Belfast—Reaping and mowing machines
1894 C. E. Brooman, Fleet Street—Breech-loading fire-arms.—A com.
1895 A. M. Clark, Chancery Lane—Pipes.—A com.
1896 H. A. Bonneville, Paris—Shuffling and dealing cards.—A com.
1897 E. P. J. L. Terrel, France—Heating wine and fermentable liquids
1898 W. F. Procter, Glasgow—Sewing machines.—A com.
1899 W. Barton, Boston—Kitchen ranges
1900 C. R. E. Grubb, Bow Lane—Match box
1901 T. E. Willisms, Newport—Pots employed in the manufacture of tin
1902 W. H. Westwood, Dudley—Gas holders

11th June, 1868.

1903 H. Turner, Leeds—Privies and ashpits
1904 S. Barlow and T. Edmeston, Stake Hill, and T. Beeley, Manchester—Furnaces
1905 W. Unsworth, Paris—Sail brakes
1906 J. Rodgers, Leeds—Belts for driving machinery
1907 A. M. Clark, Chancery Lane—Bricks.—A com.
1908 S. J. Paris, D. Drummond, and D. Hamer, Manchester—Valves
1909 E. R. Southby, Lanark—Utilizing oleaginous acid waste
1910 W. Henderson, Glasgow—Finishing woven fabrics
1911 J. S. Cockings and A. Umhach, Selby Oak—Sewing machines
1912 W. E. Newton, Chancery Lane—Cement for uniting china.—A com.
1913 J. Lord, Rawtenstall—Preparing cotton for spinning
1914 A. E. G. Thenard, Leicester Square—Utilizing waste fuel
1915 F. Warner, Jewin Crescent—Obtaining water
1916 T. Morris, Regent Street—Supporting erections on water
1917 A. S. Stocker, Horsleydown—Infants' feeding bottles

12th June, 1868.

1918 D. la F. Chase, Boston—Governors for steam engines
1919 J. H. Johnson, Lincoln's Inn Fields—Miners' safety cages.—A com.
1920 A. L. Fleury, Charing Cross—Treating quartz
1921 A. L. Fleury, Charing Cross—Treating gold and silver ores
1922 J. Gray and R. Weir, Glasgow—Treating ores
1923 J. Anderson, Ramsbottom—Preparing and spinning hard waste
1924 G. Davies, Lincoln's Inn—Cranes.—A com.
1925 L. and A. Pyke, Holborn—Shirt studs
1926 G. W. Cutmore, Holloway—Cooling liquids
1927 N. D. Spartalie, Liverpool—Burning hydrocarbon oils
1928 W. R. Lake, Chancery Lane—Anchor.—A com.
1929 S. S. Bent, Porchester—Poultry houses
1930 C. Rostaing and E. Vivet, Paris—Material suitable for making steam
1931 W. Richards, Birmingham—Breech-loading fire arms

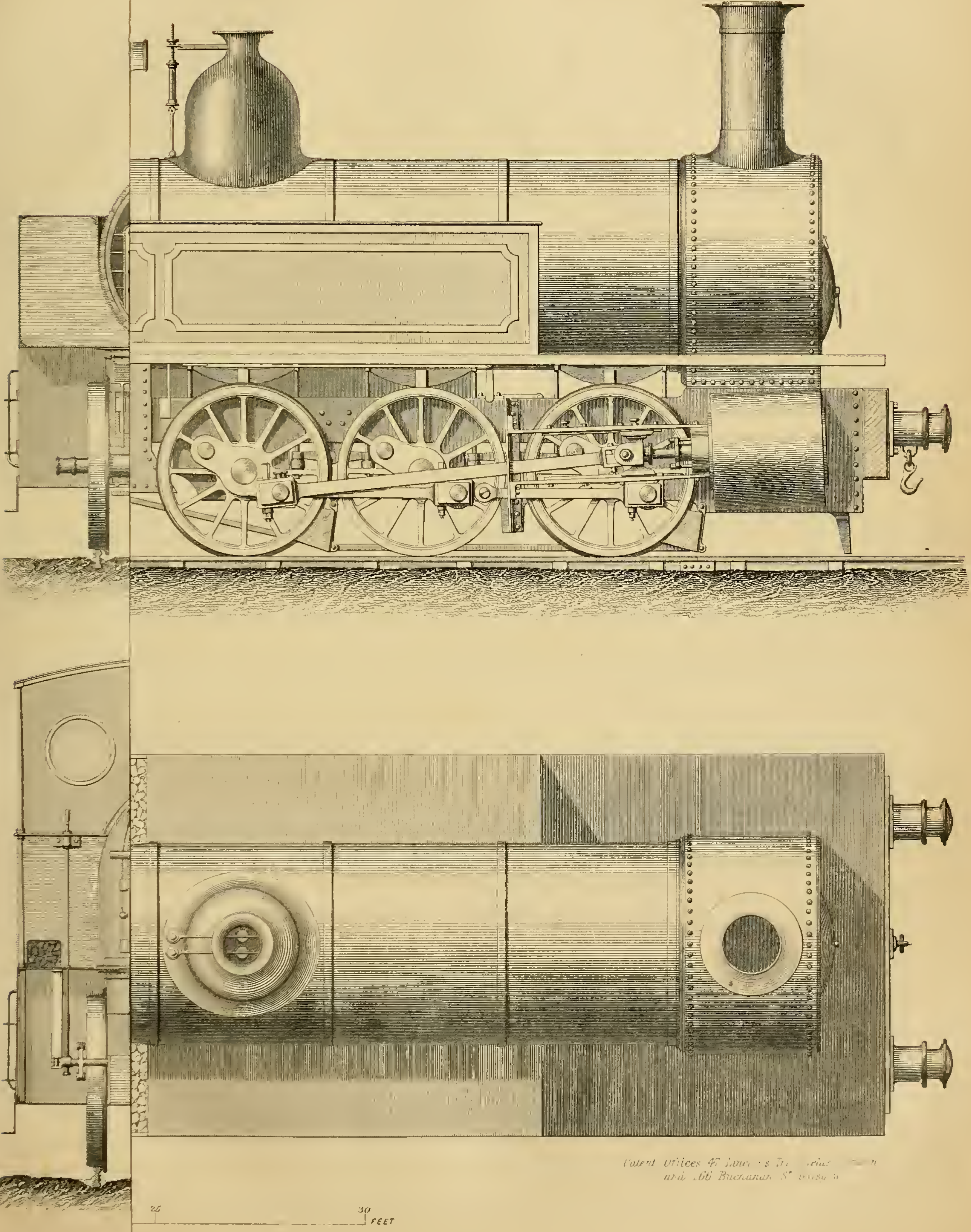
13th June, 1868.

1932 C. Humphrey, Southwark—Flexible compound
1933 J. Toft, Manchester—Turning and boring wood
1934 C. H. Mitchell, Barrhead—Steam engines
1935 C. Whitehouse, Cannock—Boring bits and augers
1936 M. and J. Mackie, Kilbirnie—Steam boilers
1937 W. Miller and G. Englert, Earl's Court—Cooling beer
1938 J. Howden, Glasgow—Steam motive-power engines
1939 W. Yates, Westminster—Furnaces
1940 H. Malsters, Westminster—Mixture or compound for cleaning gloves
1941 J. T. Parlour, Pimlico—Elevators
1942 T. H. P. Dennis, Chelmsford—Horizontal tubular boiler
1943 W. R. Lake, Chancery Lane—Hulling grain.—A com.
1944 E. Fisher, Camberwell—Tonic effervescing drink
1945 C. E. Schwartz, Hoxton—Making crystal brocatel colours
1946 J. Ball, Nottingham—Cutting off the superfluous portions of threads from spots

15th June, 1868.

1947 W. Leonard, Massachusetts—Horse collars
1948 L. S. Thomassin, Paris—Producing a combustible and lighting gas
1949 F. Worcester, Stoke—Tuyeres for furnaces
1950 J. S. Benson and J. von der Poppenburg, Birmingham—Breech-loading fire-arms
1951 T. Hendrick, Birmingham—Ornamenting fenders
1952 J. H. Johnson, Lincoln's Inn Fields—Zincing baths.—A com.
1953 C. Humfrey, Southwark, and W. S. Webster, Brunswick Square—Waterproofing paper
1954 W. C. Sillar, Cornhill, R. G. Sillar, Upper Norwood, and G. W. Wigner, Camberwell—Deodorizing and purifying sewage
1955 L. B. Prindle, Lichfield—Constructing chairs and rails

GINE.

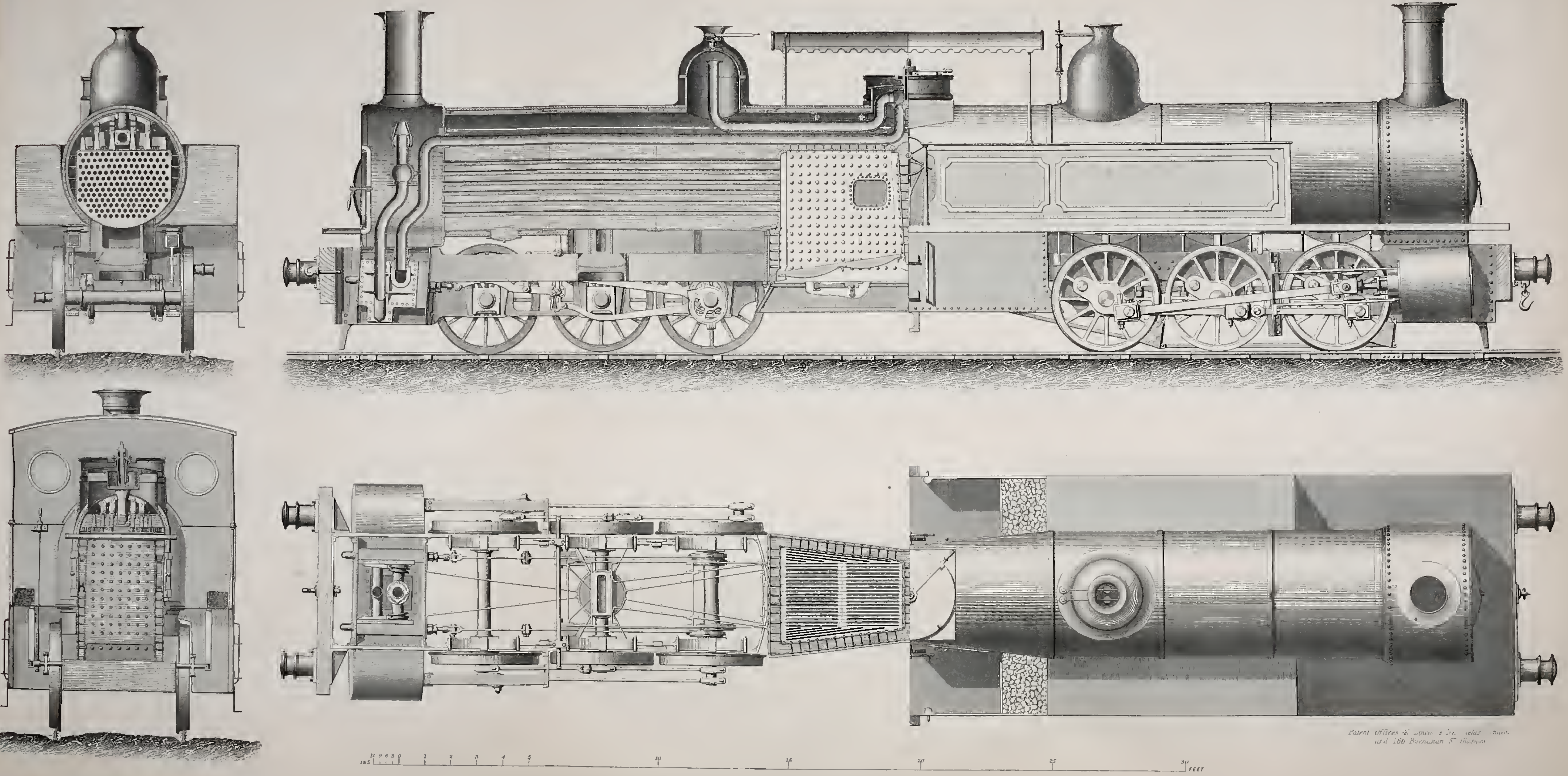


*Patent Offices 47 Lincoln's Inn Fields London
and 166 Buchanan St Glasgow*

IMPROVED DUPLEX LOCOMOTIVE PASSENGER ENGINE.

ROBERT FRANCIS FAIRLIE, ESQ. C. E.
PATENTEE.

Designed for the Mexican Railway 1868



Patent Offices 47 Lincoln's Inn Fields London
and 166 Buchanan St Glasgow

THE NEW CARBAZOTIC GUNPOWDER.

Explosive compounds multiply at present beyond anticipation, if we take into consideration the unquestionably valuable properties of several that have been latest produced. Four descriptions of the old-fashioned gunpowder, at least, must be recognized as now employed in the armies of Europe, viz., fine small-arm powder; small-grained or quick-firing cannon powder; slow-firing cannon powder; that in cakes, or *en pilons*, and the swiftest-burning powder that can be manufactured (*poudre brisante*), used for petards or torpedoes, or like uses, where the rapidity of the stroke is of primary importance. In all these the chemical composition is the same, and the entire difference in explosive effect arises from difference in the states of molecular aggregation due to the methods of manipulating the "powder cake."

Gun cotton, already become familiar to us, though only the discovery of Schönbein a few years ago, has been shown by the researches of Abel, along with those of others abroad, to be of constant constitution when prepared in the same manner, and to be perfectly stable in time and under the ordinary perturbations of climate and temperature; and, moreover, to admit of being again and again saturated in water and dried without change. Though thus always the same in constitution, any desired slowness or rapidity of combustion may be conferred upon it by merely modifying its state of mechanical condensation, so that in fact gun cotton presents to us an indefinite number of different gunpowders, so far as its ballistic effects are concerned.

Then we have still later in its chemical history, at least as at all worked out with exactness, nitro-glycerine, or Nobel's blasting oil, as it has been called, which far exceeds in rapidity of explosive stroke any other explosive agent employed upon a scale outside the experimental laboratory, except it be fulminate of mercury, or the composition thereof used for priming percussion caps. Recently this oil, the tremendous accidents with which in both hemispheres have made it popularly notorious, has been modified by the presentation in commerce of an alleged new material named dynamite in a solid form, not unlike brown sugar in appearance. In that state the agent is stated to be much safer to carry or handle, than when liquid. The tremendous effects of which it is capable have been, in our last part, indicated by the detail of some experiments made with it at Glasgow. Whether there be any, and what increase of safety, thus conferred over that of Nobel's oil, we are not in a position certainly to admit, nor yet to deny. The degree of safety in any case seems but small, and a disagreeable doubt as to the efficiency of any process of making this chemical Frankenstein tameable, is suggested by the almost contemporaneous news that Nobel's manufactory at Hamburg has been wholly blown up. However formidable and perilous may be the handling of nitro-glycerine, or dynamite, as it is named in this solid form, its use will doubtless continue. No amount of danger will deter the daring and reckless gold-digger, or the mine-explorer in wild and distant regions, from employing this material, which enables him to carry at his belt a power almost preternatural, as its effects strike the imagination. Nor is it wise that its free use should be interdicted or even discouraged; it confers too great an additional power upon mankind to be readily set aside. Wisdom and prudence suggest rather the further questioning of nature as to how best it shall be made at all times the slave, never the master, of its employer.

When of old gunpowder was in Europe a new and little known and tried thing, doubtless there were abundance of accidents with it, far more than now, though even yet they are far from unfrequent. Had it not been that gunpowder so strongly commended itself to the rulers of the earth, as being in a sort the *ultima ratio regum* quintessentialized, it is quite likely that those early accidents with it would have resulted in some such legislative ostracism of the new explosive agent, as one of our Tudor kings passed by solemn Act of Parliament upon the burning of pit coal, whose unwholesome "smoak" condemned it.

We shall not weary ourselves here with modified gunpowders, such as that which the French tried in the early wars of the great revolution (in which the nitre was replaced in part, or wholly, by chlorate of potass—a modification due to Berthollet which, we may however remark, has not as yet been fully worked out by either chemist or pyrotechnist), nor with prussiate of potass gunpowder, nor several others. Nor need we remark that although the researches of Edmund Davy have sufficiently shown that none of the metallic fulminates are likely to prove of greater technical value than that of mercury, and, for a few special purposes, that of silver, still there remains an almost unexplored field in the combinations of nitrogen with iodine, bromine, and chlorine, from which may possibly be hereafter obtained explosive agents more tremendous in power than even the nitro-glycerine, and which chemical research may find yet the means to make equally, if not even more manageable.

A new gunpowder has very recently been added to the list, which is sufficiently manageable and valuable enough in the properties it presents to have been already viewed with favour by the government of France, by the war administration of which experiments upon its manufacture are now being pursued upon a large scale at the imperial powder mills of Bouchet. This is the Picric gunpowder of M. Designolles, in which picrate or carbazotate of potass supplies the place of the nitrate of potass of the old-fashioned gunpowder.

In 1788 M. Hausmann, a manufacturer and chemist of Mulhausen, discovered the reactions of the oxidating agents upon indigo, viz., "indigo bitter," and carbazotic acid, then confounded with indigotic acid. These reactions were subsequently studied by Walter, Fourcroy, Vauquelin, and Chevreul, who in 1809 showed the nitrogenous constitution and acid properties of the "indigo bitter," and gave to the crystallized acid the name of "picric." In 1828 Liebig advanced further the study of the oxidation of indigo, and called this acid Carbazotic. Finally, Laurent showed that this organic acid is simply a derivative of phenic acid (another indigo acid) by the substitution of two equivalents of hyponitric acid for three of hydrogen, and he hence now named the acid Trinitro-phenic. This acid produces well-defined salts with most of the bases. Its composition is ($H\,O,\ C_{12}\,H_2\,[N\,O_4]_3\,O$), and its production is not confined to acting upon indigo by oxidating agents, in which event, from the great value of that body as a dyeing agent, the use of the carbazotates for gunpowder would be impossible on the ground of expense. Carbazotic acid may be obtained by the action of fuming nitric acid upon many other organic bodies. Thus, besides phloridzin, coumarin, salicin, and like bodies which are rare, silk waste and a number of resins, notably that of the *Xanthorrhea hastilis*, yield it easily, and from the latter sources it may be had in abundance. The great commercial source of carbazotic acid now, however, is from carbolic acid, which is produced in immense quantities in connection with the manufacture of the aniline dyes. The carbazotates nearly all crystallize readily, and, like carbazotic acid itself, explode more or less violently when heated suddenly to between 300° and 400°. The carbazotate of potass is anhydrous, is very soluble in boiling water, but requires 260 parts of cold for solution. It is in beautiful yellow needle crystals, insoluble in alcohol. The like salt of ammonia is also anhydrous.

M. Castbellaz, in conjunction with M. Designolles, has so improved upon Laurent's process for procuring this acid that he can manufacture carbazotate of potass at a very low price, and, when employed as a substitute for nitre in gunpowder, if the respective ballistic effects be made the basis of comparison, the statement is, that the new powder is considerably cheaper than the old and well-known one. Prime cost of the powder is not, however, alone the question, viewed as an agent of warfare. If a perfectly manageable and in all respects unobjectionable gunpowder can be obtained, which shall give the same power of launching projectiles, with, let us suppose, one-half the bulk and weight of common powder, it would at once commend itself to the careful trials of all warlike powers, even though its cost might, weight for weight, be more than double that of common powder; and amongst other reasons for this is the very obvious one, that as regards all troops, the weight of ammunition, so far as the explosive is concerned, to be personally carried would be reduced to one-half, while as regards the means, difficulties, and cost of transport of artillery and reserve ammunition, the advantages would be immense. It is no doubt chiefly on these grounds that this powder is now under trial, by order of Marshal Niel, the French minister of war.

But other advantages are said to be secured not less important, the proportion of carbazotate of potass present to constitute the gunpowder may, it is found, be varied from 10 to 1 in limits, without the mixture ceasing to be explosive. The result is, that two standard classes of powder are proposed for use—the one, *brisante*, giving an intensely rapid stroke for special military mining or other like explosive uses; and the other, which is alleged to have a greater ballistic effect than common gunpowder, at less cost, and in less bulk and weight, and with less strain upon the gun. So precisely, it is stated, can the rapidity of explosion with this agent be regulated, that, given the length and calibre of the gun, the weight of the projectile, and that of the charge, such composition can be assigned as shall give any pre-assignable initial velocity within the extreme limits, the higher of which, it is further said, transcends that of gunpowder. This absolute regularity in the burning of this new powder results from the method of its manufacture, which, so far, appears to be kept secret. One can see easily, however, that as the diverse rapidity and the uncertainty of that, in the case of gunpowder, depends upon the molecular state of each of its three constituents, two of which are crystalline, and one, the nitre, alters its crystalline state gradually by time, and especially by moisture, after the powder is made, so in this new powder; the use for projectile purposes of only two constituents, carbazotate of potass (whose crystals are soft, easily comminuted, anhydrous, and almost unaffected by moisture) and charcoal—far greater uniformity can be secured at all times, and afterwards maintained. For blasting or mining purposes M. Designolles' powder is composed simply of carbazotate and nitrate of potass; for common or small arms, of these salts and charcoal. There is no sulphur, and hence no sulphur compounds in the evolved gases of explosion, and scarcely any smoke; and the gases which are produced are not deleterious. This is a most curious and fortunate fact. When carbazotate of potass is exploded in free air, amongst its evolved products are found hydrocyanic acid and binoxide of nitrogen. The result in formulæ is thus—

$$C_{12}\,H_2\,K\,(NO_4)_3\,O_2 = \text{Carbazotate Potass.}$$
$$= N + NO_2 + 4\,CO_2 + HC_2\,N + HO + (KO,\,CO_2) + C_5,$$

when exploded free in air; that is to say, the gases are—nitrogen, binoxide of nitrogen, carbonic acid, hydrocyanic acid, and vapour of water, the only solid residues being carbonate of potass and charcoal. But when the same is exploded in a close vessel, as in a gun, the products are different, and are as follow, namely—

$$= 3\,N + 5\,CO_2 + 2\,H + O + (KO + CO_2) + C_6;$$

that is to say, nitrogen, carbonic acid, hydrogen, and oxygen, the solids being carbonate of potass and charcoal, as before. So that exploded in free air the gases are poisonous, but exploded in a confined space they are innoxious.

It seems practicable to employ, for certain special purposes, carbazotate of ammonia, and so to avoid any solid residue whatever. It will be seen at once that the products of explosion in guns of this powder will be less noxious to the gunners, in casements or between decks, than the smoke of ordinary powder; that the evolved gases are nearly free from producing obscuration, often an object of high importance, especially for shore batteries firing at ships in motion, when moments are precious as well as unimpeded view; and that the evolved gases are of such a nature as to produce no corrosion in small arms or in cannon.

This new powder is prepared with the ordinary machinery for gunpowder existing at the Bouchet Mills. The materials are triturated by stampers (the mode preferred in France) with from 6 to 14 per cent. of water, for a time which varies between three and six hours. The powder is pressed into cake by the hydraulic press, with pressures varying as 1 to 2, according to the rapidity of combustion desired. It is grained or corned by machine work, glazed and dried in the ordinary ways. The methods employed are always the same for the same ballistic power, to vary which the inventor varies only the proportion of carbazotate.

Of this, for small-arm powder, 20 per cent. has been found enough. For great-gun powder the proportion varies, according to the aim in view, between 8 and 15 per cent. Besides projectile or explosive (mining or blasting) powders, MM. Designolles and Casthellaz have shown that powders of great value for pyrotechnic purposes may be obtained from various carbazotates with metallic bases. Thus fast-burning golden rain fire is produced by 50 parts carbazotate ammonia, with 50 parts carbazotate of iron; green fire, of carbazotate ammonia 48 parts, with 52 parts of nitrate of barytes; red fire, of 54 parts carbazotate of ammonia and 46 parts of nitrate of strontian, &c., &c. We are not informed whether carbazotate of strontian has yet been tried, nor any of the metallic carbazotates, such as those of antimony or zinc, which might probably afford characteristic pyrotechnic effects.

It is stated that the results of some ballistic experiments with cannon, already made, have shown that, with like projectiles and charges, equal initial velocities have been obtained within limits of variation not exceeding 2 or 3 metres per second. This we fear is "too good to be true," though we have every confidence in the probability of far greater constancy than can be had with common powder.

While Casthellaz and Designolles deserve all the credit, as regards this powder, that properly belongs to those who first fully work out and prove the value of a project, they cannot justly claim to be the first inventors of this powder. Walter, in the year III. of the French Republic (1795), was the first to propose the substitution of "indigo bitter" for nitre, about the same time that chlorate of potass was proposed to supply its place. No source but an impracticable one was then known for this acid, however; and chemistry was not advanced to the state to be able to predict what would be the nature of the gases that a powder made with it would evolve when exploded.

The whole of the explosive compounds or gunpowders, so far known, may be divided into two great classes—those which on combustion, whether quick (*i.e.*, explosive) or slow, leave *solid* residues, such as those left by common gunpowder; and those which wholly *disappear into permanent gases or vapours*, as is the case with gun cotton, nitroglycerine, dynamite (probably), and with carbazotic powder with ammonia base. In one respect this latter class of powders possess an importance quite their own. They present to us the possibility of procuring a prime mover analogous to that of compressed air or of high pressure steam, in cases where expense is but a secondary object and the saving of bulk and weight everything, such as is not presented to us in any other direction by the powers of nature, so far as these are now known to us.

If ever the aeronaut is to advance his favourite hobby beyond the point of mere loose speculation, and of fair game for the ridicule of the unbelievers in flying, it must be by procuring power for his artificial Pegasus, by resorting to some such source of it, when acting either directly by reaction or upon a piston, as may yet be manageably obtained by the slow and regulated combustion of gun cotton, or of carbazotic ammonia gunpowder. Over the former, which nevertheless presents so many other advantages, carbazotic powder presents this important and unique advantage, that whereas every increase of gaseous pressure tends to make gun cotton burn faster in a close vessel, and so at last to explode with unmanageable violence, carbazotic powder on the contrary being already as solid as heavy pressure can make it, should, if in a mass, burn always at the same and the designed rate. As compared with compressed gunpowder, of which this is nearly equally true, it presents the immense advantage that it need not evolve any solid substances, the deposit of which in the interior of any machine working with elastic gases as motors is fatal.

It is a possibility that a few years may witness the applications of carbazotic powder to purposes widely different from those of warfare; and strange as it would be, that a substance originally produced by a tinctorial plant in small quantities, acted on by the conjuring hand of the chemist, should be used to propel cannon shot and to navigate the air, there would be in these nothing more extraordinary than chemistry has already given us other instances of in abundance; as, for example, that pit coal should afford us heat, light, power, dyes, perfumes, and flavours—all the latter three rivalling those which nature herself presents to our delighted senses.—Ed.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXX.

Malleable Cast-iron Castings.

In the preceding paper we traced the early history to the present day of this branch of iron founding, and, we trust, cleared up some points in the narrative further than had been done by previous writers. We now proceed to describe the methods and practice of the manufacture, and to offer some remarks upon the commonly accepted view as to the theory of the cementation process, which appear to us sufficiently doubtful to stand in need of much future experimental investigation before they should be longer accepted as presenting any true solution of the phenomena. It will be most convenient, however, to reserve our consideration of the principles involved in the process, until after we shall have described the methods of the manufacture as they are now conducted.

In effect, the manufacture of malleable castings, for whatever uses these are intended, or whatever be their sizes or forms, is conducted everywhere upon almost precisely the same methods. These have been long handed down, and seem scarcely to have been reasoned upon. No branch of iron manufacture is really more completely a matter of unthinking and unimproving routine. In outline the process consists everywhere in melting the pig iron—generally in crucibles of clay, rarely in small cupolas with coke fuel; pouring the melted metal into castings, the moulds for which are of green or of dry sand; removing the objects cast from the sand; clearing them from what may be adherent of the latter, by various methods dependent upon the nature of the objects themselves; packing the objects cast into "saggars," or cases, of cast iron filled with powdered red hæmatite, mixed with more or less of the same material which has been previously employed; piling up these filled cases into suitable annealing furnaces; exposing them then to heat gradually increased to a full red, to which they are exposed for a certain and considerable time; letting the whole cool down; removing the cases or saggars from the furnace; cleansing the objects they contained from any of the adherent hæmatite powder; and then, the special process for malleableization being complete, treating the objects in such ways as their special nature demands, prior to their being finished, packed, and sent to market. "The trade" may be divided into two classes—those engaged in the production of small and very small objects, and those engaged with larger and the largest objects to which the process is applicable; but except in certain details, which we shall notice, the process is conducted alike in all cases.

The pig iron employed everywhere appears to be hæmatite iron, and of this only the lower numbers are deemed suited. For very small objects mottled hæmatite pig is used; for those of larger size white pig—quite as white as "refinery iron." Reaumur leads us to suppose that *he found in use*, for making malleable castings in France, only Ulverston pig iron, which M. Brüll, in his memoir, to which we have already referred, informs us comes from "Scotland." The Cumberland iron of Reaumur's day was made with charcoal, and both from that and from the nature of the ore (red hæmatite), was no doubt one of the purest sorts of iron which was then known in France, and perhaps chosen with that view. Its steely tendency and comparative freedom from sulphur and phosphorus were not then known. Lucas, in his specification, does not refer to any particular pig iron, but the writer has been informed by his descendants that they believe he always used Westmoreland or Cumberland iron, and they use the latter still. The pig iron from the Barrow Ironworks is largely employed, and is used for this manufacture in Belgium. The *exclusive* use of hæmatite pig, however, is simply a matter of uninquiring tradition. It is *probably* a fact that iron as free from sulphur and phosphorus as may be, submits itself most readily and fully to the annealing process; and it *is* a fact that very hard or mottled pig iron, which never melts quite as fluid, nor runs as freely in the mould as soft graphitic irons—at equal temperatures above the fusing point—runs *most* fluid when most pure, or at least sulphur-free; and to this extent the choice may be a good one, where other and equally good hæmatite irons are not to be had. They are abundant in Germany, however, where much hæmatite is smelted.

But the common belief of the malleable iron-founders, that no other iron but Cumberland pig will answer the purpose, is devoid of any foundation. It is a fact, which the writer has himself ascertained, that *any white* pig or other cast iron, will answer perfectly well for malleable castings. In works under his control, hollow naves were for some time made for the iron wheels of certain wrought-iron wheel-barrows for "navvy" use, patented by the late Mr. William Mallet. These wheel naves were cast in iron moulds, which were prepared to receive the inner ends of the four flat wrought-iron radial spokes of the wheel, which the nave united together when cast upon or around them. These naves, in form a sort of hollow pair of cones united base to base, were nowhere more than about ⅜ inch thick; mainly less than ¼ inch in thickness. From this, from contact with the iron spokes, and from being cast in iron moulds, upon sand cores, the cast iron in them was perfectly chilled. White iron alone was used for casting these, but the iron used was picked out from the "scrap heap," and consisted mainly of old cylindrical sash weights of Scotch make, which had already been cast in iron moulds and so chilled, and of old "smoothing irons," and "cart axle boxes," or any other iron in the heap that showed a white fracture. The chilled naves and wheels were bedded in rough sand from the furnace-house floor, to which a good deal of useless "cast-iron borings," which was in store and had got rusty and useless for "iron cement," was added and mixed through, the main object being to increase the conductivity of the mass. In this material the naves were annealed for a sufficient time (seven or eight days of twenty-four hours), and never failed to become perfectly soft and tough.

In recent conversation with two highly intelligent malleable-iron founders the writer mentioned these circumstances, and heard with some surprise that they were not acquainted previously with the fact that any white pig iron can be cemented malleable, and they entertained the usual sort of doubting prejudice as to such being so.

The really essential condition seems to be that the iron shall be white or mottled; that is to say, that the whole, or very nearly the whole, of its carbon shall be in combination. If the graphitic or diffused carbon be got out first, either by burning out as in "the finery," or by "chilling," any brand of pig iron, we believe, may be employed for the malleable casting process. How far the existence of a large proportion of sulphur, or even of diffused silicon, might affect the result, we are not in a position to affirm; but it is scarcely likely that either will be met with in white pig iron which runs tolerably fluid when in fusion. The steely tendency (*prepension acierieuse*) of hæmatite iron, which M. Brüll appears to think has something to do with its special suitability here, appears to us to be no more than this—whatever pig iron possesses this steely tendency is, or is nearly, sulphur-free, and sulphur-free *white* iron runs better in the moulds into small objects than does pig rich in sulphur. To this extent only, viz., as a testimony of the absence of sulphur, has the steely tendency, we believe, any relation of a direct sort with the malleable casting process.

The "gaits" are always melted up again, as well as "wasters" or "bad castings," and these, from their small scantling, are absolutely white and glassy in fracture. The ordinary method of melting everywhere consists in the use of clay crucibles of from 50 to 100 lbs. capacity, which are almost always made in the foundry. These are heated in wind furnaces, supplied with coke fuel of the usual construction. In England these furnaces are ordinarily built square in plan; they sometimes are made to contain two crucibles, and then are oblong or rectangular in plan. Abroad they are frequently cylindrical, and constructed as in figs. 1 and 2, the former being a vertical section showing the out-draught flues, *x x*, and the latter plans at level of the top of a furnace, and just above the grate, *z z′*, being the apertures to the ash-pits and for air supply, and covered by a foot grate of iron bars. The fire bars are of wrought iron. This is in some respects not a good arrangement, and when the method of heating the crucibles by direct contact with the solid fuel is employed, and upon a large scale, the melting furnaces should be constructed precisely like those for cast steel, viz., with the mouths of the entire range of furnaces on the floor level, and the grates and ash-pits in a vault beneath, so that the air-draft comes in to them all from below. The furnace room above is thus prevented from being inconveniently heated, and the whole working of the furnaces, as well as the withdrawal of the pots, is facilitated.

Fig. 1.

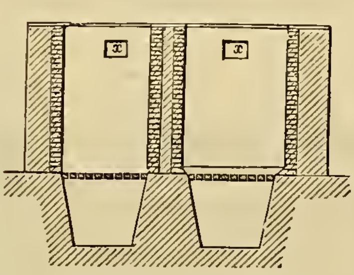
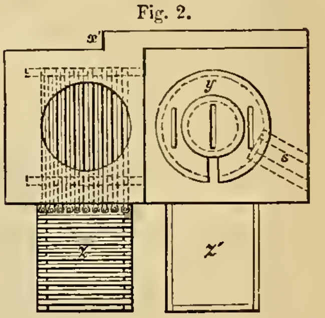


Fig. 2.



Where the foundry is on a sufficient scale, however, every argument enforces the substitution of Charles J. Siemens' gas-heated regenerative steel crucible furnace for those above referred to. These furnaces are shown in plan and horizontal section in fig. 3, and in vertical section, through U W, in fig 4. In one such furnace eighteen or more crucibles are heated at once, and in place of the pig iron melted, requiring nearly double its own weight of coke, at perhaps 20*s*. to 25*s*. per ton, with Siemens' furnaces a ton of *steel* is melted by the consumption of the gases from a ton of small refuse coal, costing perhaps 7*s*. to 9*s*. per ton; and with even a less proportion may white pig iron be melted.

In these gas furnaces the ignited flame of the mixed gas and hot air passes across and between the crucibles, let us say from left to right (as shown by the course of the arrows in fig. 4), and the otherwise waste heat is taken up by the mass of brick in the air and gas chambers on the right-hand side of the figures. When the corresponding fire-bricks in the gas and air chambers at the left-hand side of the figures have got cooled down so far that the gases do not fully inflame, then the flue dampers are reversed, and the ignited mixed air and gases now come in through the right-hand and now hottest chambers, traverse the furnace and crucibles, now from right to left, and then descend by the outlet chambers to the left, heating once more the bricks therein—ready to repeat the process again. The change is made once in three or four hours, according to the size of the furnace, &c.

Fig. 3.

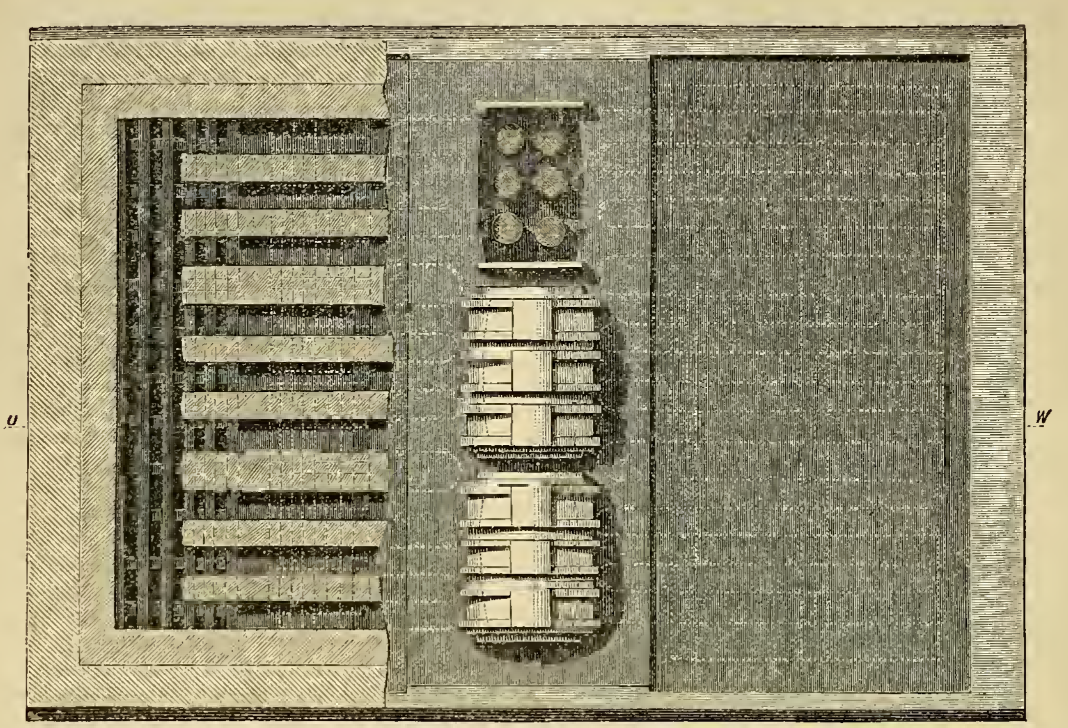
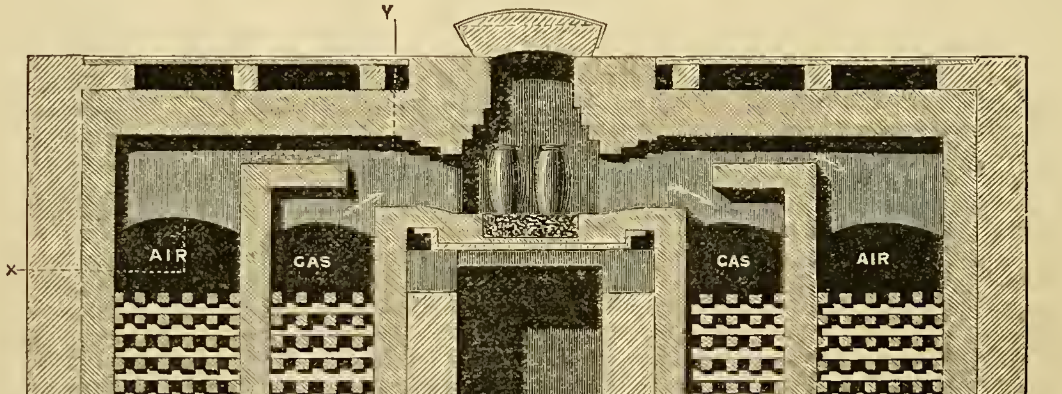


Fig. 4



Such is the regenerative crucible furnace of Charles J. Siemens, which may be seen at work in his Steelworks in Birmingham and elsewhere. It constitutes one of the most important improvements ever made in the means of heating crucibles, not only effecting this with great economy, but enabling the matter in the crucibles to be preserved free from any deleterious influence from the direct contact of the fuel, and admitting of the mixed air and gas flame being regulated with precision as to its oxidizing, neutral, or deoxidizing powers; while with the "regenerative principle" in use, any temperature can be steadily commanded that the material of the furnace itself will bear without being melted down.

We have been thus full in referring to and illustrating this gas crucible furnace, because its use has a wider relation to the general subject of these papers on the Practice of Iron Founding than merely their employment in malleable casting foundries. Pot founding, as it is frequently called—*i.e.*, melting iron for small castings in crucibles—is considerably employed in various branches of small, ornamental, or other founding, as, for example, in making the well-known "Berlin castings," or others which are moulded by "bench moulding." Wheresoever this is practised on a sufficiently large scale, the Siemens gas furnace will prove the best means for melting in the crucibles.

Where the objects cast in "malleable foundries" are tolerably large (for that trade), each piece weighing, for example, 50 or 60 lbs. or so, then not uncommonly the white pig iron is melted by coke in a small cupola, and by the ordinary fan blast. In Reaumur's time, when iron founding generally was absolutely in its infancy, all the castings made for "malleable work" were produced from iron melted in a curious little sort of baby cupola, worked by two pairs of hand double bellows. These cupolas, when larger, were tapped out as usual now; but smaller ones had a loose or separate bottom piece (usually made out of an old pot), which was lined with clay, and became at once the receptacle of the liquid iron and the ladle from which it was poured. They were, in fact, the curious old "Callebasse furnace," the nature and history of which we have described in a previous part of these papers. This bottom or ladle was lifted for pouring, by a rude sort of *chevalet*, a large lever pole pivoted over the top of an upright post, of about 5 feet high, fixed into the foundry floor; the whole constituting the most primitive germ of the modern foundry crane. Curious engravings of all this may be found in Reaumur's memoirs, who tells us that this germ of a crane was, when he wrote, a novelty, and the invention of an ingenious workman, M. Cusin, of the Fauxbourg St. Antoine at Paris. Previously the liquid metal in the *poche* or ladle was handled in the same unsophisticated manner as a cook takes a pot of "brose" off the fire.

The moulding operations for making malleable castings are conducted both in green and in dry sand moulds. The boxes or flasks are often still of wood, but more generally of cast iron, made light and handy, and of sizes and forms suited to the class of castings constituting "the trade" of the particular shop. The work being, in fact, all relatively small, the whole of the moulding is done by "bench work." In England, the moulding sand usually employed is from the new red sandstone; it is a *very fine* uniformly grained sand, with a sufficient amount of naturally mixed fine intermingled clay, to work well and *stiffly* without any prior preparation by clay wash. In and about Birmingham the sand used is obtained from pits at Moxeley, a few miles off. At Sheffield the sand preferred is a soft, half-disintegrated, red sandstone from Rowsley, which requires to be ground and sifted. Sand from the former locality is used for very small work, without admixture of any charcoal, except what it receives from successive "facings." For larger work, it and the Rowsley sand are mixed, as usual for other mouldings, with some powdered charcoal.

The nature of the patterns used depends upon the class of work, and will be best referred to when we shall describe in detail two or three "malleable foundries" as now actually at work. Except for the larger classes of work, such, for example, as parts of cotton machinery, averaging half an inch to an inch in thickness, facing is really unimportant; with the very small articles, such as three-prong forks, cutlery in general, shoe nails, horse nails, and so forth, the metal must be poured at so intensely high a temperature to insure its fully "taking the mould," that facing becomes useless. Nor is it with these important that the sand should be as infusible as would be indispensable with heavier pieces; for the metal is so rapidly cooled by contact with the relatively large volume of sand, that there is not time for fusion of the latter superficially to take place. The metal of the castings, whether small or large, if these are what they ought to be, is found perfectly white, sub-crystalline, as if chilled, and extremely brittle, and the amount of contraction appears to be greater than with softer cast iron. At any rate, from the rapidity of the cooling and this contraction together, the castings more or less break off from the gaits, almost directly the metal has "set;" and when a box is "stripped" the contents are found separated into numerous portions, and not unfrequently fracture takes place through the castings themselves, if the form of the piece has been ill judged, or if the connecting neck between the piece and the "gait" be made too thick and heavy. This demands a special precaution, invariably adopted by the moulder in "malleable ware," namely, to make all his "gaits and runners" as small in cross section as he can manage to do with, and to make their form in cross section always *flat*, *wide*, and *very thin*. This, as the runners are formed in the "parting" of the box, is easily managed. Probably the necessity for this had been discovered by the workmen in Paris or Normandy before Reaumur's time; but in one of his memoirs he very clearly points out the necessity for it, and explains the reason accurately. Moulders who are engaged on the very smallest class of work, to assist their vision of the exactitude with which the sand mould is finished, sometimes dust over the moulded faces with fine powdered *white* clay, or with wheaten flour, as often used by brass moulders. The "parting" of the boxes is never made with "parting sand," which would scarcely do for such fine work, but with some fine dry clay powder. Some men use white, some a red clay, like "bole" of the older apothecaries, either having been sifted through a silk "tammy" sieve. The dry sand boxes are dried in little stoves, often formed so as to be heated by the waste or radiant heat from the crucible furnaces, or by distinct coke fires; from the very small mass of the sand these dry very rapidly, and without any changes of form, which in much larger work renders caution, and perhaps adjustment in closing the dry sand box, necessary. When the boxes are poured and "the work stripped" the pieces are separated from the sand by raking out with an iron hook, &c., when large; or when very small, by sifting out the castings, by passing the sand through an iron wire "riddle." Large work is "fettled" by hand; any adherent bits of "runner," "fins," &c., being adroitly *broken* off by the edge of a steel chisel or sharp-edged hand hammer, as neither file nor chisel will cut the material.

The small work requires to be cleaned effectually from adherent sand, some particles of which cling occasionally rather obstinately. For this purpose such work as will admit of it, as shoe and other nails, peculiar rivet washers, in a word anything roundish or short, is put into revolving iron barrels with a hand-door and lid, and in these by mutual attrition they are soon quite clean. Forms which will not admit of this are cleaned by hand—by children, usually small boys; and others (though not commonly) are "pickled," *i.e.*, cleaned by immersion for some hours in very dilute sulphuric acid, after which having been washed in water, they are dried either on hot plates or in desiccated saw-dust, prior to being put into the saggars or annealing pots. The floor of the room in which the annealing pots are opened and their contents taken out, is formed usually of cast-iron plates, so that the fine hæmatite cementing powder is, when sifted out from the "malleable work," neither wasted nor mixed with dirt, &c.

The annealing pots now chiefly employed, are cylinders with covers of cast iron dropping in, in the clear, each about 12 inches diameter by 15 inches in height, and with sides and bottoms about $\frac{1}{2}$ inch or $\frac{5}{8}$ inch thick. These, though they "scale" a good deal at each heating, last a long time, probably on the average for fifteen or twenty operations. For larger work or long articles special forms and sizes of annealing pots are made, and in jobbing work, which sometimes reaches malleable foundries—where something unusual either in size or form is encountered—temporary pots, or rather cases, are made out of thin plate iron bent up and roughly united in the least expensive manner.

Wrought-iron plates scale so fast, by the prolonged action of the gases of the annealing furnace acting on them for ninety or one hundred hours, that they seldom answer more than two or three times. The material nearly always, though not, as we shall see further on, universally employed for filling in the annealing pots between "the work," is a mixture in variable proportions, of new or fresh powdered red hæmatite, with that which had been before employed, and which after the first operation has got into the state of intermediate oxide, or "Hammerschlag," and has become more or less slightly coherent also. For larger work, a greater proportion of new hæmatite is usually mixed with the previously used, than for smaller pieces; but the actual proportions seem very much a matter of "rule of thumb." It is stated that after the same hæmatite has been several times used, if without admixture with new, it ceases to act satisfactorily, unless ground up. This may arise from the particles getting so crystalline and hard, as well as agglutinated, that the powder is no longer *fine enough* to play its part. The new hæmatite is ground to about the size of small mustard seeds, and the impalpable dust is sifted out from it prior to its use.

The mode of filling in the annealing pots is as follows:—A stratum of about 1½ inch thick at most is spread over the bottom of the pot; then a layer of "the work," each piece being kept from contact with any other; then a layer of hæmatite, not more than ½ to ¾ inch in thickness; and then more work, until the pot is full within about 2 inches. Over that, 1½ or rather more of hæmatite is spread, then on top a layer of fine dry sand (occasionally, but not uniformly, in practice) and then the cast-iron plate cover, which comes fair and flush with the top edge of the pot. As the several pots to form one furnace full are filled, each is marked with chalk, so as to know its contents; so that they shall, when piled over each other in columns in the annealing furnace, occupy known positions in the furnace, and their contents be known when about to be "drawn." In placing into the furnace, it is usual to arrange the pots containing the heaviest articles in the parts of the furnace which are known to attain the highest temperature. The usual time during which the annealing operation is continued is about eighteen or twenty-four hours, to bring up the heat of the furnace to full redness; then from sixty to eighty hours' time during which that temperature must be steadily maintained; and then the furnace being partly opened, about twenty-four to thirty-six hours are allowed for the cooling, after which the pots, though still too hot to handle even on the outside, are taken out with suitable tools, and placed upon the iron-plated floor. The work is not taken out until almost quite cold; if taken out while too hot, the castings lose some of the fine deep, sanguine, bluish black, which they are esteemed for having well and uniformly developed.

Fig. 5.

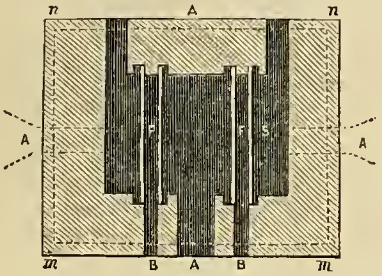
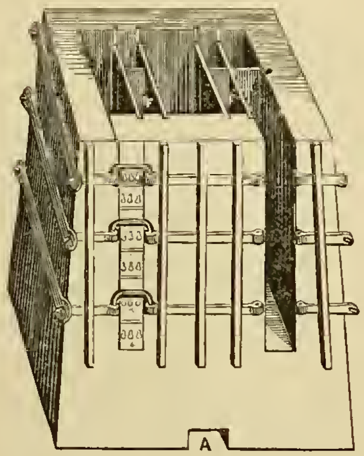


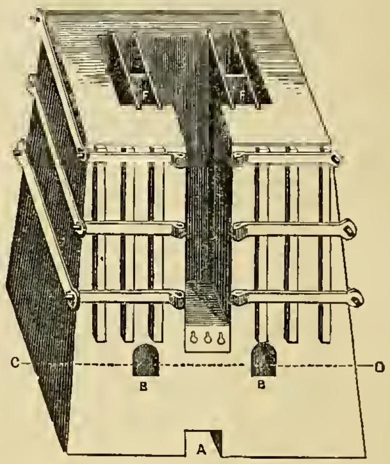
Fig. 6.



Articles of considerable bulk, partially or wholly—*i.e.*, of more than ¾ inch to 1 inch thickness—are frequently submitted to a second annealing before they are rendered sufficiently malleable. This, however, is not indispensable; and it would probably be much better practice to let such remain in the furnace without cooling for a sufficient time longer. The second annealing heat, in fact, generally arises from the fact that pots containing larger and smaller articles are put into the same annealing furnace; and the latter are needed to be withdrawn as soon as their malleability has been secured, and before it has reached sufficiently into the heart of the larger pieces; hence these have to be heated again. We shall recur to this, however, when treating of the physical characteristics and nature of the change which occurs in the annealing.

The furnaces for annealing employed in Reaumur's time are shown in figs. 5, 6, and 7, and are transcripts nearly from those given in his memoirs. They were common rectangular kilns, as shown in horizontal section, at the level of C D, in fig. 5. Each had four ash-pits and apertures for air draught to the fires, A A, in the figs.; B B were the firing holes for wood fuel. The vertical slots in the walls, two in that *n n* (fig. 5), and one in that *m m*, were filled with fire-blocks, with tongs' holes or recesses to lift them by, some of which are shown in fig. 9.

Fig. 7.



Cylindrical pots do not seem to have been known as yet, and the iron cases for holding "the work" bedded in the cementation powder were formed of cast-iron flat plates secured together parallel to each other, as shown in fig. 8, and stood up vertically in the kilns in the positions shown at F F in all the figs., 5, 6, and 7. Into the space between each pair of these vertical plates, which for convenience were made so that several ranges, standing edge to edge upon each other, occupied the entire height, the cementation powder and "work" were packed in. The top of the kiln is not shown in any of the original figures, which are very imperfect, nor whereabouts the indraught flues from the wood fires entered the interior; but it is pretty obvious that the roof of the kiln was a segment arch, and that the outdraught flues consisted of one or more apertures rising through that, at the sides or centre, and that the flame of the wood fuel rose simply upwards along both faces of each of the parallelopipedon cases, F F. These flat cases were sometimes further supported by struts of iron placed as at S, fig. 5, between their sides and the walls of the kiln, to prevent the former bulging when heated and soft.

Fig. 8.

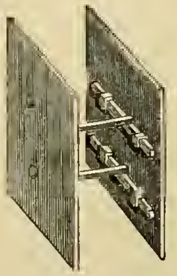
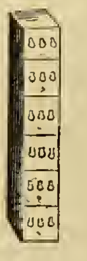


Fig. 9.



Many of the annealing furnaces still in use show by their construction that they are lineal descendants of those ancient structures. But others of considerably improved plan are also in use, and very lately the greatest advance of all has been made by the application of Siemens' gas furnace to this special use. By this means the whole available area of the kiln or furnace becomes filled with a magnificent gas flame, which may be regulated how we please, as to its reactive powers or its produced temperature. Not only is a great economy in fuel the result, but a considerable saving in time and in the destruction of annealing pots is thus secured.

In our next article we shall give illustrations of the more improved annealing furnaces now employed, and proceed with the remaining steps of the manufacture, concluding with some remarks as to the probable theory of the process.

In concluding the present paper, we may give the following catalogue, extracted from M. Brüll's memoir, which gives the nature of one day's work of a large malleable iron foundry at Paris, and which gives a good idea both of the extent and variety at the present time of this interesting manufacture:—

TABLE OF ONE DAY'S WORK IN MALLEABLE CASTINGS AT A FOUNDRY IN PARIS IN 1862.

Classification. as to purpose.	Designation of Pieces.	Numbers.	Weight of each piece.	Total weight.
			Lbs.	Lbs.
Saddlery,	Bridle-bits,	20	1·10	22·00
	Mouth-pieces of bits,	30	0·22	6·60
	Stirrups,	60	0·99	59·40
	Spurs,	150	0·33	49·50
	Various buckles,	500	0·24	120·00
Coach-making,	Pole-ends,	40	0·17	6·80
	Footsteps,	20	1·54	30·80
	Sockets,	30	0·19	5·70
	Mud-catchers,	10	3·52	35·20
	Lamp-carriers,	12	0·99	11·88
Lock-smithery,	Keys of any size,	1000	0·11	110·00
	Pieces of locks,	300	0·17	51·00
	Lock-cases,	300	0·33	99·00
	Bolts,	100	0·06	6·00
	Various hinges,	100	0·08	8·00
Armoury,	Various pieces of revolvers,	160	0·66	105·60
	Gun-breeches,	60	0·11	6·60
	Trigger-guards, and pieces of gun mechanism,	100	0·06	6·00
	Bullet-moulds (two pieces),	40	0·44	17·60
Scale-making,	Cross-beams of various size,	60	0·66	39·60
	Cross-bars for scales,	120	0·12	14·40
	Pumps,	120	0·09	10·80
Mechanics,	Pieces for screw spanners,	80	1·32	105·66
	Nuts,	200	0·06	12·00
	Draw-plate shells and wrench,	10	1·10	11·00
	Gearings,	15	4·40	66·00
	Pieces of spinning-machines,	90	0·66	59·40
	Handles,	25	0·55	13·75
	Plugs for cocks,	30	0·44	13·20
	Pieces for copying presses,	15	4·40	66·00
	Pieces for sewing machines,	60	0·77	46·20
	Covers for grease-boxes,	120	0·88	105·60
	Dies for printing,	180	0·77	138·60
Cutlery: Table-articles,	Table knives, hunting knives, daggers,	180	0·26	46·80
	Butcher-steels,	20	0·66	13·20
	Pruning-shears,	100	0·66	66·00
	Carving-forks, game-forks, oyster-forks, fish-forks, fish-trowels,	80	0·24	19·20
	Nut-crackers,	140	0·40	56·00
Ironmongery,	Chain Swivels,	100	0·27	27·00
	Sauce-pan handles,	120	0·99	118·80
	Various hand-tools for shoemakers,	100	0·55	55·00
	Cones for coffee-mills,	50	0·26	13·00
	Various ornaments,	15	1·76	26·40
	Hat-rails,	20	0·30	6·00
	Conical ferrules for tool-handles,	500	0·03	15·00
Variety,	Matrices for florists,	40	1·10	44·00
	Ladles for foundries,	12	2·64	31·68
	Melting pots for the precious metals,	1	57·86	57·86
	Pieces for shoe-lasts,	25	0·99	24·75
	Statuettes,	4	5·50	22·00
	Pieces for water-cocks,	260	0·33	85·80
	Total,	5924		2200·00
	Average weight of one piece,	...		0·37

Ed.

ANCIENT COINS AND METHODS OF COINING.

By Joseph Newton, Royal Mint.

There is so much that is interesting and also instructive in tracing the origin and history of almost every branch of manufacturing art and mechanical industry, that no apology seems necessary in entering upon an inquiry into the annals of coining. It has been recently demonstrated in these pages that the art of money-making has, in this country at least, reached a very high state of perfection; and so great is the estimation in which our gold coinage especially is held, that the sovereign is now accepted as an actual, if not a legal tender, in almost every part of the civilized world. In fact it is no longer a local, but has become a universal coin, and passes current everywhere. The art of coining, however, has passed through numerous gradations. At a very early period in the history of mankind the precious metals were used as standards of value, and with regard to gold, its first employment in the capacity of money was probably in the form of portable ornaments. It is on record that the discoverers of America found that the natives of the vast continent had long previously been in the habit of using rude ornaments of gold as media of barter, and down to this day some of the Indian tribes of Central and South America employ trinkets of gold and silver in lieu of money. There is much that is of a mythical character in regard to the actual period and place at which coined money was first used. It is certain that no such thing existed in Egypt down to the time of the Ptolemies, and at the date of the Trojan war its use was unknown to the Greeks. Neither Homer nor Hesiod mentions gold or silver coin, but, on the contrary, they invariably express the value of commodities by stating that they were worth so many oxen or sheep. It is mentioned by Homer that Laertes bought the beautiful slave Euryclea for 100 oxen, and in the seventh book of Pope's version of the Iliad it is observed in reference to business transactions among the Greeks that:—

> "Each in exchange proportioned treasures gave,
> Some, brass or iron; some, an ox or slave."

As a sample of the doubt which existed in the minds of ancient writers as to the origin of coined money, it may be cited that Lucan attributes its invention to Itonus, king of Thessaly, and son of Deucalion, the hero of the mythological deluge, and who is said to have re-peopled the earth! Others ascribe it to Ericthonius, king of Athens, the reputed son of Vulcan, who had been nurtured by Cecrops. Aglaosthenes gives the credit to the inhabitants of Naxos. A more generally received opinion among numismatic students and archæologists of the present day, is that the invention of stamped money is due to Phidon, king of Argos and contemporary with Lycurgus and Iphitus. It is thought that this monarch introduced coin into Ægina to enable its inhabitants to earn a subsistence by commerce; their own island being too small in area, or too barren, to yield a sufficient supply of cereals. We stand upon more certain ground when we assert that Darius, the son of Hystaspes, was the first sovereign who coined gold in Persia. The coins minted by him were called Darics, as the gold pieces of Philip of Macedon, father of Alexander the Great, were termed Philips. The Persian coins were of a very high degree of fineness, and one of them preserved in the earl of Pembroke's collection weighs 129 grains, or the exact theoretical weight of an English guinea.

So long as Persia maintained her independence the Darics circulated largely; but after the Grecian conquest of that country it is supposed that they were melted down in great quantities, and re-coined with the image and superscription of Alexander. Dr. Prideaux says that in those parts of the Scripture which were written after the Babylonish captivity, Darics are mentioned under the name of Adarkonim, and in the writings of the Talmudists under that of Darkoneth.* The word "talent" in Homer is used to signify a balance, but was applied either to a weight or a sum of money differing in value at different periods. Every talent consisted of sixty minæ, and every mina of one hundred drachmæ. In English money the Babylonian talent was equal to £226, and the Euboic or Attic talent to £193 15*s*. It may be as well, before leaving this part of our subject, to observe that the famous treasures of Attalus and Crœsus comprised no actual money, but only gold and silver in the mass. Their enormous wealth was derived from mines in Lydia, situated between Atarna and Pergamos.

The relative value of gold and silver in ancient times fluctuated very much. In the reign of Darius, for example, gold was thirteen times more valuable than silver, whilst in the days of Julius Cæsar the proportionate value of gold to silver was as nine to one only. The depreciation no doubt arose from the prodigious quantity of the more precious metal, which Cæsar obtained by the plunder of cities and temples. It has been suggested, and is believed by many respectable authorities of the present day, that the continued importations of gold from Australia and California may, in time, cause further fluctuations in the relative values of the two metals in question. This is a speculative and debatable point, however, and there is no need to enter upon its discussion here.

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* Beloe's Notes to Herodotus, Melpomene. Fourth Edition.

According to Duncan, in this instance, we believe, a reliable authority, the word money is derived from *moneta*, which itself is derived from the verb *monere*, to admonish or advise. The Anglo-Saxon word *monige*, the German *muntz*, the French *monnoie*, the Italian *moneta*, and the Spanish *moneda*, are all distinctly traceable to the same Latin root as our English word money. Again, our word "pecuniary" is derived from the Latin *pecunia*; and Cicero tells us that *pecuniosus* denoted a man rich in flocks of sheep, for he says of such fortunate individuals "*A pecore pecuniosi appellati.*" Advancing now from our general view of the invention and introduction of stamped money into the transactions of the human family, it may be desirable to direct attention to the particular part which it played during the dawning of civilization, and after the birth and establishment of commerce in England. There is little room for doubt that in Britain, as in almost all other countries, the metallic currency was immediately preceded by such rude substitutes for barter as strips of leather, lumps of salt of a certain weight, shells of some particular kind, &c. By some it is supposed that the very earliest approach to the art of coining in the British Isles consisted in the cutting out of discs of leather, and giving them impressions by force of hammer. Carew, in his "Survey of Cornwall," published in 1602, mentions the finding sixty years previously to that date of certain "leather coins," upon the surfaces of which distinct impressions could be traced.

It seems certain, however, that the earliest description of coins, if so they may be termed, consisted of rings of metal. Cæsar speaks of the Gauls using "gold and iron rings of certain weight," and makes a statement of a similar nature in relation to the ancient Britons. A confirmation of his assertion is to be found in the shape of actual specimens at present in existence of "ring-money" of gold and brass. Oxidation has in all probability been fatal to those made of iron, although it is related that in Cornwall pieces of this metal of a singular form and character have been discovered, and which may be supposed to be examples of the money referred to by Cæsar.

The ring-money was in all cases graduated as to weight, and it was made in that form, apparently, for the sake of portability, and for lessening abrasion. It consisted simply of pieces of wire cut to certain lengths, and then bent into the shape of rings. In many instances the ends of the wire were flattened and impressed with rude devices. Cast-brass ring-money was also used. These were adjusted on a graduated system, of which the pennyweight was the unit. Some of the larger specimens of the ring-money of gold are very beautiful. Without pursuing the question as to this form of currency having been the very first used by the aborigines of these islands, it may be observed in confirmation of the theory that some African tribes bring gold ring-money to Sierra Leone up to this day. No doubt exists that the practice, among them, of making it has been transmitted from generation to generation for many centuries.

The loop-money of Ceylon, generally known as fish-hook money, would also appear to be a modification of some ancient system of ring money. An old traveller has said in regard to its loop-like shape:—"'Tis in the form of a fish-hook, and pure silver. If they do suspect the goodness of it, their custom is to heat it red-hot in the fire and then put it into water, and if it be not pure white, it is not current money."

Cæsar, in his "Commentaries," says, in reference to the state of civilization which he found existing in Britain, that the inhabitants have "both gold and bronze money, or, instead of money, rings adjusted to a certain weight." The "coins" were based on Greek models, and were indeed in many instances rude copies of the "Philips" before alluded to. Their resemblance to the originals, it is true, is not very striking; but in examining them in large quantities the gradations of attempted imitation are apparent. They are thicker than the Roman money of the same period; and, unlike it, the pieces are concave, or "dished." It is evident that they were cast in dump form, and then forcibly impressed with an unintelligible device by means of a die and hammer. In some cases where the metal was of an obdurate nature, or unskilfully annealed, the coins exhibit radial fissures extending to the outward circumference of the coins. The British-Greek money, as it may be designated, is peculiar to Britain; and none like it has been discovered elsewhere.

It appears to be pretty clearly established, that a short time before the Roman invasion certain princes of the British tribes placed their names upon the coins minted by themselves. Tasciovan, Commius, Cunobelin, Dubnovellaunus, Epaticcus, Epillus, and others, are demonstrated to have adopted this plan of perpetuating their names. Afterwards it became the practice to affix the names of particular localities to coins, as proofs of their having issued from authorized mints. One example may be named as exemplifying a large class of coins produced at this period (55 to 13 B.C.), and it has the abbreviated word ANDO., signifying Andovera, which place occupied the site of the present city of Andover.

Before advancing to the time of the Roman occupation of Britain, and speaking of the money which then circulated so extensively, it will not be deemed irrelevant perhaps to refer to a class of coins which Mr. Noel Humphreys says has puzzled numismatists greatly, and which is assuredly curious in itself. These coins came into existence during the epoch just mentioned. They are formed of a mixture of zinc and tin, as proved by assays carefully made, and were manifestly cast in *wooden* moulds. In fact, the imprint of the grain of the wood which formed the moulds is in some instances so distinctly to be traced as that a careful observer, without microscopic aid, may determine its kind. The types of such coins of this description as we have seen, are those of the Macedonian "Philips;" but alas! the degradation is so great as to constitute the imitations mere caricatures. In the Isle of Thanet several specimens were discovered a few years since; and they were minutely described at the time by Mr. Fairholt. It is conjectured that they were struck by private persons for small change, just as in later times traders and others struck tokens of lead or copper for their own and their customers' convenience. If this hypothesis be correct, and it presents itself with some claims to credibility, it gives to a remote age what was long supposed to be a modern innovation. So far as the writer is aware, this use of wooden moulds for the production of coins or tokens is unique.

The complete subjugation of the southern parts of this island was accomplished, A.D. 43, by the Emperor Claudius; and the first allusion to Britain on Roman coins is on those of that monarch. It is believed by archæologists that no Roman mint was constituted in any part of the island before the time of Constantine. It would no doubt form a most interesting inquiry to endeavour to ascertain, and then to recount, the enormous variety of coins which circulated throughout Britain during its 400 years' occupation by the Romans; but we shall confine ourselves to the most remarkable circumstances connected with the coinage at that epoch.

BOILER EXPLOSIONS IN FRANCE.

THE *resumé* of the officially recorded steam boiler explosions occurring in France during the years 1865 and 1866, has just been published. It is a masterly document compared with the reports of our voluntary "Boiler Associations," and by an exhaustive process of discussion of the results obtained from the returns, throws a good deal of light upon the actual causes of these explosions.

The following are the chief numerical results:—

Total number of explosions,	Year 1865,	13
	Year 1866,	18

Total number injured,	Killed,	25	in 1865
	Wounded,	25	
	Killed,	15	in 1866
	Wounded,	22	

		1865	1866
Nature of application of the boilers,	Iron and metal works,	6	3
	Manufactories,	7	12
	Towing boats,	—	2
	Winding engines,	—	1

As respects the nature of the boilers themselves there were:—

	1865	1866
Horizontal cylindrical boilers with or without fire cylinders,	9	12
Cylindrical vertical boiler with internal fire, no tubes,	2	2
Boiler with "return water" feed apparatus,	1	"
Steam pipes,	1	"
Horizontal tube boilers for tow boats,	—	2
Winding engine boilers (no description given)	—	1

PRESUMED CAUSES DIRECTLY OF EXPLOSION.

	1865	1866
Defects of construction, bad quality of metal (plates), bad arrangement of the furnace,	7	5
Negligence in working the boiler,	6	10
Indeterminable causes, but all more or less attributable to negligence or hardihood on the part of the men attending the boiler,	—	3

The *moral* of the whole is, just as in former years, that boiler explosions are mainly of the same class as those so-called accidents that result from people presenting guns at others not knowing they are loaded, &c., and quite as preventible.—Ed.

PENCIL-LEAD MINES AND LEAD-PENCILS.

Most persons know what a black lead-pencil is, but it is not generally known that there is not a particle of lead in the pencil. The material variously known as black lead, graphite, or plumbago, is almost wholly composed of carbon. It probably owes its misnomer to the fact that, previous to the employment of graphite for making pencils, common lead was used, and this within the present century. For a long time the best graphite was obtained, not in very large quantities, at Borrowdale, in the English county of Cumberland, where it was discovered in 1564, early in the reign of Queen Elizabeth; and pencils, much like those still in general use, were produced in the year following. As the supply of the graphite (known in Cumberland, while in the mine, by the title of *wad*) was not large, the British government from the first took great pains to prevent the exportation of the article, and even to limit its home sale to a supply just sufficient to meet the estimated demand. Graphite is found in various parts of Europe, and even in North America, but of very inferior quality. The Cumberland mines were worked only a few weeks in each year, yet the yield of *wad* was estimated at £40,000 a year. While the graphite lasted, England had a monopoly in supplying the best pencils to the world. Year after year, for a century past, the graphite deposit in Cumberland became "small by degrees and gradually less." The result was that graphite powder had to be compressed into a solid cake from which pencils could be supplied. A French variation, said to be an improvement, was to mix the powder and purified graphite with clay, which is largely done still.

Nearly 150 years ago the pencil manufacture, commenced in England and improved in France, was transplanted to the village of Stein, near Nuremberg, in Bavaria; and little more than a century since, Casper Faber there began to make the pencils which continued to be made by his descendants, and bear the family name through the world. The present John Lothair Faber, great-grandson of Casper, has been head of the firm since 1839, and is not only very wealthy, but has recently been ennobled by the king of Bavaria. One of his brothers is associated with him, at Stein, in the processes of manufacture; the youngest of the three, Eberhard Faber, represents the firm for the Western World, at New York. Stein is literally a town of pencil factories, of which Baron Faber is the ruler, taking care of the health, government, education, industry, thrift, and amusements of the inhabitants, always living in their midst. It may be asked, How do the Fabers make lead pencils without the famous graphite from Cumberland? It appears that twenty years ago John Peter Alibert, a Frenchman resident in Asiatic Siberia, having heard of the gold discoveries in California, began to examine the sandy beds of various rivers flowing into the Arctic Ocean. He found samples of pure graphite, evidently brought a considerable distance by force of the stream, in one of the mountain gorges near Irkutsk, and pursuing his discovery, tracked back to a branch of the Salan Mountain range, on the very summit of Mount Batougol, 275 miles west of the town of Irkutsk, near the Chinese frontier, in the midst of the rocky desert, and found pure graphite. After years of costly labour, Alibert found an exhaustless deposit of graphite equal to the best ever taken from Cumberland. Beside decorating and rewarding him, the Russian government changed the name of Mount Batougol to that of Mount Alibert. Nearly every crowned head in Europe has honoured him. With the consent of the Russian government, Alibert now supplies Faber's house exclusively with graphite from the mine in Asiatic Siberia. Pencils of this material were first made by Baron Faber in 1861, and were not introduced into the American market until 1865, from which time artists and others perceived and acknowledged their superiority. If the world were to endure a thousand years more, there is sufficient graphite in Mount Alibert to supply its population with good black-lead pencils.—*Paper Trade Review.*

[Faber's pencils are unquestionably of excellent quality, so far as their general freedom from grit (in all the higher classes of pencils), the fine tint of their marks, and the ease with which they work in the hand of the artist, for free hand sketching. They, however, possess one positive and undeniable evil, which almost unfits them for the uses of the engineering, mechanical, or even architectural draughtsman. It is nearly impossible to erase with india-rubber the marks once made on paper by these pencils. What this may arise from—whether from a peculiar molecular constitution of the plumbago from Siberia, or from its being (as it is stated is sometimes done) boiled in oil, before being sawn into slips—we do not know; but the fact we have personally verified, and we believe that it is owing to this that the employment of Faber's pencils is as yet so small in Great Britain. If Messrs. Faber can rectify this, we have no doubt they will enlarge their British market. This note, therefore, is suggested, not by any hostile feeling, but the contrary.—Ed. *P. M. J.*]

EGROT'S NEW CONTINUOUS STILL.

M. Egrot of Paris has recently exhibited, at Havre, a new still, for which he claims the following advantages:—The small volume occupied by this apparatus, for both distilling and rectifying, renders it extremely easy to be erected. The uniting of the two principal portions, the boiler and the condenser (cooled by the mash itself, so as to economize as much as possible the heat given out by the worm), is managed in the most convenient manner. They are both placed vertically on brick or stone foundations of easy construction, and as there are few connecting pipes, the fitting up presents fewer difficulties than accompany other stills. On account of the small space required for Egrot's stills they can be set up when other apparatus would be inadmissible; whilst in case of removal from place to place, or exportation, the cost is considerably reduced.

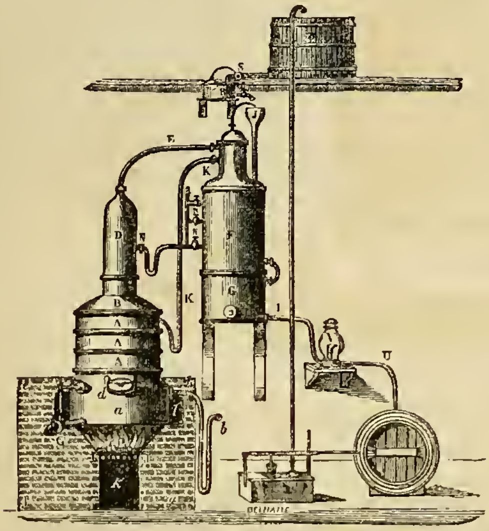
The economy of fuel is not less remarkable. Owing to its small dimensions the Egrot still offers less surface to the air, and does not lose caloric by radiation to any great extent; in fact, the larger the apparatus the more it costs to carry on distillation. The economy of fuel in these stills is mainly effected by the peculiar construction of the diaphragms or dishes, so that during the process of distillation the steam, being subdivided, is placed in direct contact with the wine in circulation, which it subjects to a violent action, resulting in a forced ebullition, setting at liberty all the alcohol contained in the liquid.

Nothing can be more simple than the working of these apparatus. As there are only from three to five diaphragms, according to the alcoholic richness of the wines, the distillation is effected without pressure, and consequently without fear of the wine, wort, &c., being carried over by the steam, in the shape of froth, instead of alcohol. This impediment in the working of many stills is thus completely avoided by Egrot's apparatus, the principal advantage of which is the effecting distillation by operating on the surface.

The degree of rectification, especially that of alcohol, obtained from wines by these stills, may ordinarily amount to from twenty-four to fifty-eight over proof; in fact, the distillation can attain any practicable degree, according to the will of the operator. Owing to the small volume of these stills the first cost and installation—a most important point—is considerably diminished, compared with the expenditure of larger apparatus. Another interesting feature, essential in all practical machinery, is their facility for being cleaned or taken to pieces.

The accompanying engraving shows an elevation of Egrot's still: *a* is the copper boiler; *b*, a siphon tube for the continuous discharge of the wort, mash, or vinous residues; *c*, a discharge cock for emptying the boiler when necessary; *d*, a man-hole; *e*, *f*, *g*, *h*, masonry of the furnace; *i*, the furnace; *j*, grate-bars; *k*, the ash-pit; *l*, a circular flue. If steam be used from a generator to work the still, the furnace becomes unnecessary, and the boiler can be filled with wine instead of water. A A A A, column composed of diaphragms distilling the wine, &c., continuously; B, still-cover supporting the rectifying column, D; E, conduit pipe conveying the alcoholic vapours to the serpentine rectifier and wine heater; F, envelope containing the rectifying worm; G, envelope containing the serpentine refrigerator; I, flow pipe from the refrigerator; J, funnel receiving the wine and conveying it to the bottom of the wine-heater, F; K, tube conveying the wine to the first diaphragm; N N N, tubes and cocks for bringing back the crude alcohols to the rectifying column, D; S R, ball cock regulator and cistern; T, regulating cock with a dial plate to aid the operator; U, tube leading to the testing glass; V, the tester wherein the strength of the spirit is ascertained; Z, wine or mash reservoir.

In order to start the still, the tub, Z, is filled with wine or wort to be distilled by means of the pump, Y; then the cock, T, is opened, so that the wine can pass to the refrigerator, G, the wine-heater, F, and the distilling plates, A A A A, taking care that the wine does not arrive at the boiler, a. When a naked fire is used, the boiler, a, is filled with water by the aperture, d, and the fire is lighted; the steam of the water, as soon as it boils, passes through each of the plates, A A A A, and takes off the alcohol contained in the liquid; thence the alcoholic vapours mount in the rectifying column, D, where they lose their empyreumatic flavour, and enter by the tube, E, into the serpentine rectifier, F; lastly, having been rectified according to the will of the operator, these vapours are condensed in the refrigerator, G, and pass in a liquid state through the pipe, I, to the testing glass, V, where a hydrometer marks the degree of strength of the alcohol obtained.



The wine or mash takes an opposite course to that of the alcohol; it is introduced into the still by the dial-cock, T; the funnel, J, which receives it, conducts it to the base of the vessel, G, raising successively the several layers of liquid contained in G and F; the wine passes from the upper portion of the wine-heater by the tube, K, to the first plate of the distiller, A A A A; then to the second, and so on till it escapes, completely exhausted, by the siphon tube, b.

In passing through the plates, A A A A, the wine meets with a number of heating tubes, which soon set free the alcohol; and thus, if from ten to fifteen minutes are sufficient to exhaust the wine, it will be easily understood that, owing to the short period of caloric influence, empyreumatic or injurious oils have not time to be formed, or pass over with the product. This is one of the advantages of the Egrot stills, which give a prompt distillation with an apparatus of small dimensions.

Additions can be made to these stills in several ways, so as to render them as useful and as remunerative as possible under different circumstances. In some countries, such as Spain, where very rich wines are distilled, alcohols are obtained exceeding sixty per cent. overproof. When the wines or fermented juices to be distilled contain much alcohol, say ten or twelve per cent., an additional diaphragm must be placed, so as to extract the whole of the alcohol from the liquor. In every case a pump such as is manufactured by Egrot, seen in engraving, worked by the hand, and placed in a box resembling a garden engine, is necessary. It is so contrived as to be capable of being shifted whenever necessary, and to be available as a suction or force pump, or both. It can render signal service, moreover, as a fire-engine, on account of its great portability.

DE TYGER AND *DE BUFFEL.*

In an article, page 99 of the present volume, entitled "The latest Clyde-built iron ships and designs," we gave many particulars as to

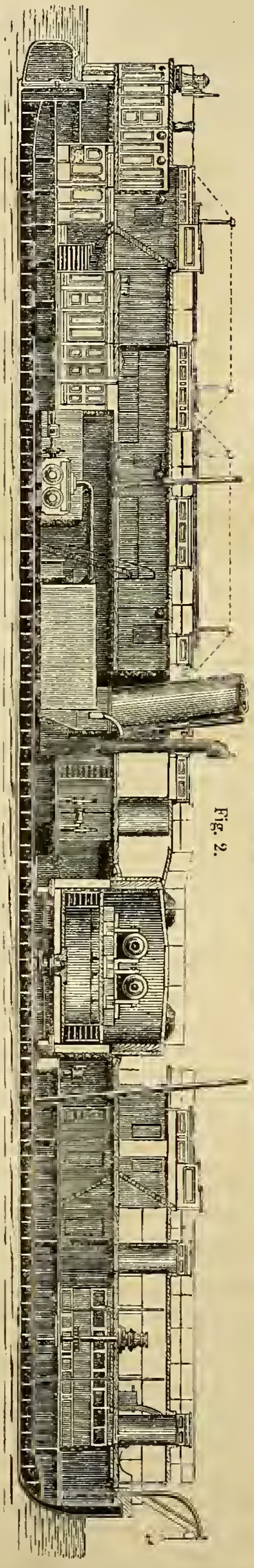


Fig. 2.

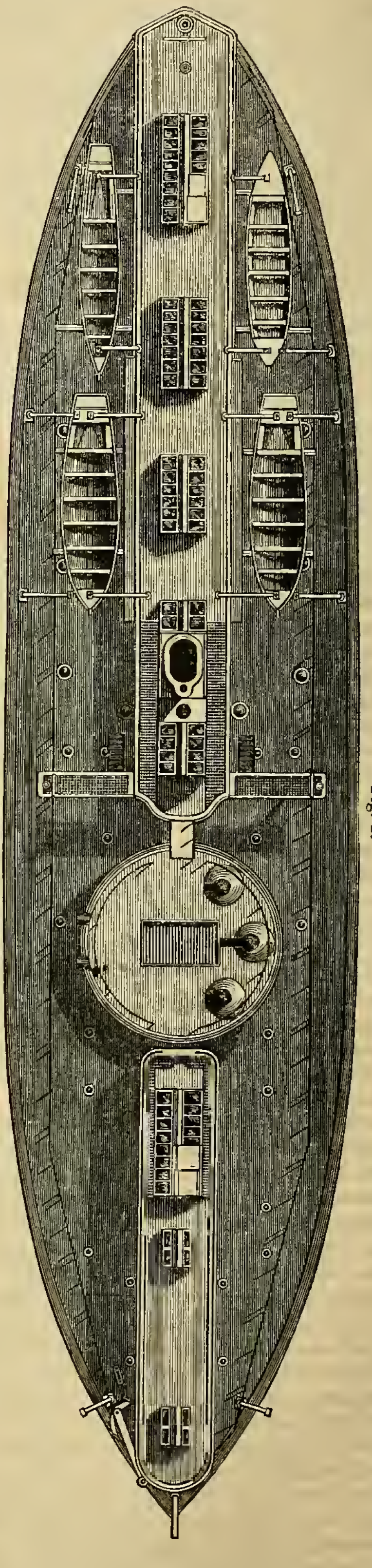
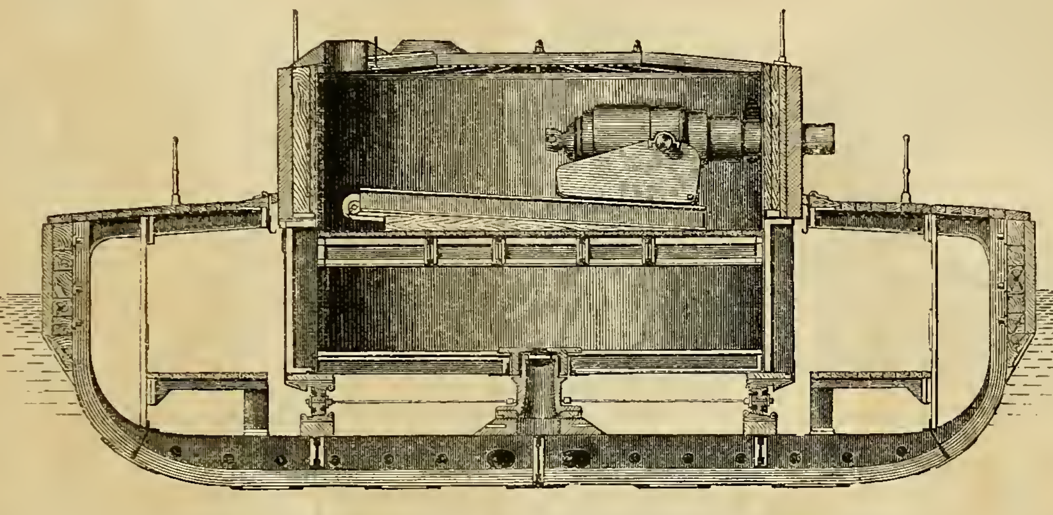


Fig. 1.

dimensions, structural design, engine-power, &c., of these two remarkable vessels, which have been built by Messrs. Robert Napier & Sons for the Dutch government. Since the appearance of that article, these war ships have been tested as to their general qualities and behaviour at the measured mile in Wemyss Bay. The monitor *De Tyger* was the first tried on July 3rd Her steering capabilities were first proved; and it was found that, by the aid of her twin screws, she could be rapidly turned a complete circle, after which her speed was tested by six runs, giving the following results:—1st run, 10·084 knots an hour; 2nd, 9·836 knots; 3rd, 9·917 knots; 4th, 9·449 knots; 5th, 9·945 knots; and 6th, 8·738 knots. The speed in the last run was quite exceptional, the falling off being probably occasioned by the priming of the boilers. The average speed of the six runs was about 9¾ knots an hour; and of the first four runs 9·945 knots. Two runs were subsequently made with half power, only one boiler being brought into operation. The first gave a speed of 8·200 knots, and the second 7·692 knots—the mean being 7·946 knots. Some experiments were likewise made with the turret. With steam power the massive structure was made to perform a complete revolution in 45 seconds. This speed is considered to be sufficient for all practical purposes; but, if necessary, the revolution could be accomplished in half a minute.

Fig. 3.



The *De Buffel* (combined ram and monitor) was tried on July 4th, when with her twin screws both in action, one going ahead and the other astern, the complete revolution was performed in 4·5 minutes, and at the measured mile she gave a mean out of six runs of 12·82 knots; but we understand a higher speed was anticipated; in this case also it was diminished by the priming of the boiler. To make our readers further acquainted with these rather novel ships of war, we have engraved the annexed plan, fig. 1, and sections, figs. 2 and 3, of the *De Tyger*.—V.D.

ROYAL AGRICULTURAL SHOW.

THE busy town of Leicester, situate as it is almost in the heart of the agricultural and manufacturing districts, and well supplied with railway communication from all parts of England, has been judiciously selected this year as the scene of the Royal Agricultural Society's Annual Show. The display was certainly one of the largest, if not actually the largest, on the society's records; whilst the standard of excellence in the various implements exhibited has been well maintained. The show yard was situate on what is now called the Victoria Park, about a mile distant from the railway station, and embraced an area of about 50 acres. For facility of comparison with the shows of former years, we may remark that there are 6369 articles catalogued on 337 stands, of which 5384 come under the denomination of agricultural and miscellaneous implements and machinery, and 587 under the head of machinery in motion.

Taking the heavier descriptions of machinery first in order, we may mention the extensive display of excellent and powerful steam-ploughing machinery exhibited by the firm of John Fowler & Co., who have deservedly obtained the first and second prizes in this class. They exhibited one 20 horse-power double-engine set of steam-ploughing machinery, three sets of hauling apparatus of 10 horse-power, one of 8 horse-power, and a traction engine, with several of their balance ploughs.

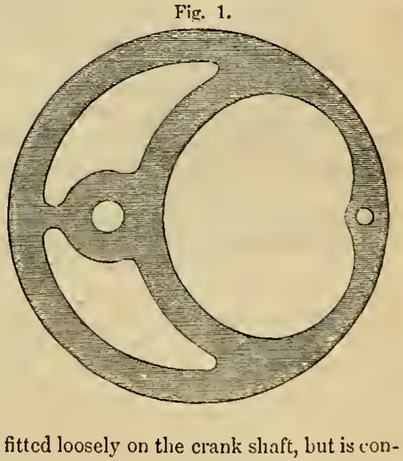
Messrs. J. & F. Howard also exhibited steam-ploughing apparatus admirably adapted for *moderate-sized* farms, and have carried off the first prize in this class.

Aveling & Porter exhibited a set of steam cultivating and ploughing apparatus on the Fowler system, but with improvements introduced by the exhibitors. Also, one of their celebrated 10 horse-power traction engines, which was hard at work, dragging in its rear a long train of implements brought up from the trial field.

One of the most interesting and useful exhibits at the show was "Little Tom," a road locomotive and crane combined, by Aveling & Porter, which was managed entirely by a boy of thirteen. The jib of the crane is fitted to the front of the engine, and the hoisting chain passes longitudinally under the harrel of the boiler and up through the foot-plate, and is wound on to a windlass barrel compactly placed over the fire-box, and driven by gearing from the engine. The ease and rapidity with which a stone of about 2 tons weight was lifted from and into a waggon, and carried about the ground by this active little engine, astonished all beholders. We may here notice, whilst on the subject of cranes, a well-arranged 6-ton locomotive steam crane, by Appleby Brothers, and exhibited with improvements by Joseph Jessop, of Leicester.

Amongst the other exhibitors of traction engines we may mention the names of E. R. & F. Turner (represented by a 5 horse-power engine), Ransomes & Sim's, William Tasker & Sons, and Robey & Co., all of whom exhibited various well-constructed engines of this description Messrs. Ruston, Proctor, & Co. had four portable engines on the ground, ranging from 6 to 12 horse-power, and provided with Chapman's variable expansion eccentric. The essential object of this eccentric, of which we annex engravings, is to economize fuel by enabling engines to be adapted to the exact power required by the aid of only a single eccentric and slide valve. The eccentric itself (fig. 1) is fitted loosely on the crank shaft, but is connected by a bolt and nut with a disc *a* (fig. 2), which is fast on the shaft, and has a curved slot, *b*, made therein, for the purpose of enabling the

Fig. 1.



eccentric to be set in any desired position, and there fixed by the tightening nut. A pin is passed through the eccentric on the side of the shaft opposite to the tightening bolt, the head of such pin sliding to and fro along a short radial groove, *c*, made in the disc, when the eccentric is turned thereon for adjustment. This is a most simple and useful contrivance for engines, such as these, having a wide range of duty. Fig. 3 represents an edge view of the eccentric and disc connected together.

Fig. 2.

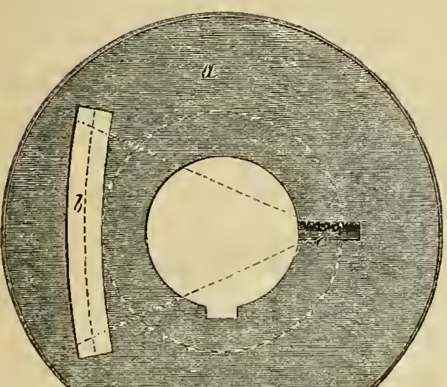
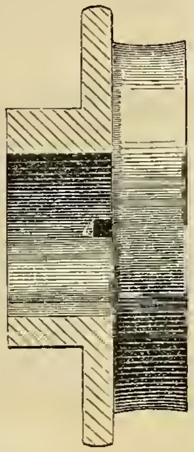
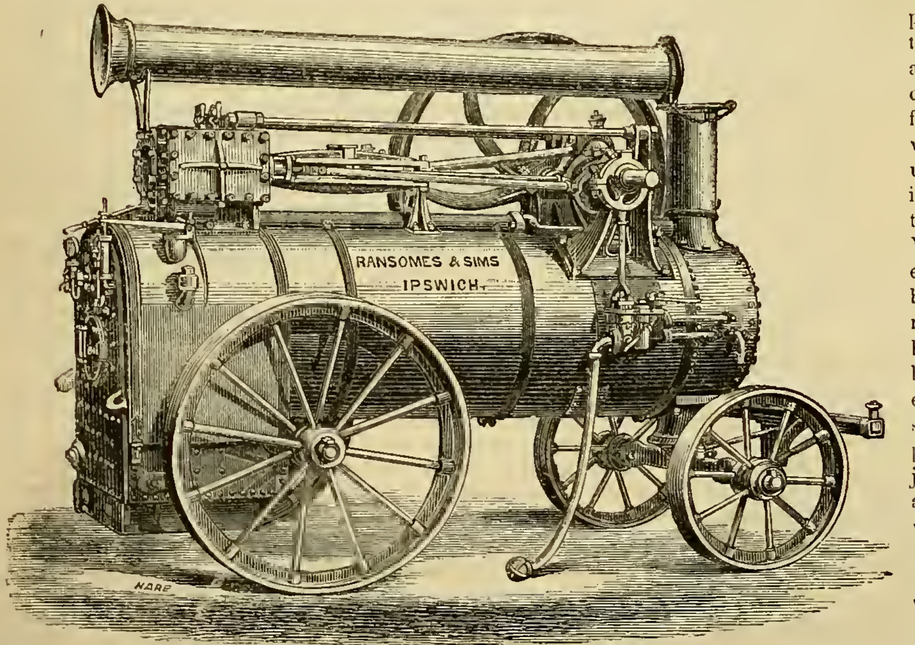


Fig 3.



Richard Garrett & Sons exhibited a 6 and 10 horse-power portable engine, and a locomotive of 8 horse-power. Messrs. Tuxford & Sons were represented by several of their well-made and well-known portable engines, but without any special novelties attached. Amongst the portable and fixed engines we saw nothing superior to those of Clayton, Shuttleworth, & Co.; the judicious arrangement of parts, and the admirable workmanship displayed in these engines, reflect the greatest credit on the firm.

Fig. 4.



The cylinders are steam-jacketed, and the exhaust is used for heating the feed water. We noticed two engines by Messrs. Brown & May of 6 and 8 horse-power respectively, fitted with a very compact feed-water heater and exhaust condenser disposed along the framing.

The portable engines of Messrs. Ransomes & Sims, one of which we illustrate, are specially designed and constructed to economize fuel, and to regulate its consumption according to the power required; the engines exhibited are single-slide engines, but the same firm also manufacture double slide engines. These engines were provided with a feed water-heater or reservoir, placed in the smoke-box of the engine, in which the water is heated by the exhaust steam and hot air passing from the fire-box to the chimney. A double feed pump is in connection with this heater by means of pipes shown on the side of the engine; one pump draws the cold water from the supply tank and discharges it into the heater; the other is supplied with hot water from the heater and forces it into the boiler.

The slide valve is on the gridiron principle, and the pressure of the steam is removed from the back of the valve by means of metallic equilibrium relief rings kept up to the faces of the slide-case cover by means of spiral springs; these valves are found to be as easily moved when the pressure of the steam is on as when it is off.

The cut-off or expansion valve is worked by a movable eccentric, the position of which can easily be altered so as to cut off the steam at one-fifth, one-fourth, one-third, and one-half. The arrangement for adjusting this eccentric is very simple: it is held in its place by a nut screwed to a bolt fixed to the fast eccentric, under which is placed a pointer which slides on a plate graduated with the various grades of expansion and fixed to the other eccentric, and the engine driver has only to adjust the loose eccentric until the pointer reaches the mark in the grade which corresponds with the point at which the steam is cut off in the stroke of the piston.

These engines are constructed from 6 horse-power to 20 horse-power, and their average consumption does not exceed 3·5 lbs. per horse-power per hour, of ordinary coal. The general construction of the engine is very strong, steel and wrought iron being used wherever practicable, and the various parts are amply strong and well-proportioned, so as to work up to three times the nominal horse-power. The travelling gear, wheels, and axles are immensely strong, and calculated to resist the most severe shocks.

Amongst the lighter and miscellaneous machinery and implements we may mention Hall's clever and ingenious rock boring and tunnelling machine, exhibited by Appleby Brothers. The boring tools are diamond-faced, and cut out a solid core from the rock by a combined rotatory and longitudinal motion. Several efficient steam pumps were exhibited by S. Owens & Co., also a compact, little, direct-action donkey engine.

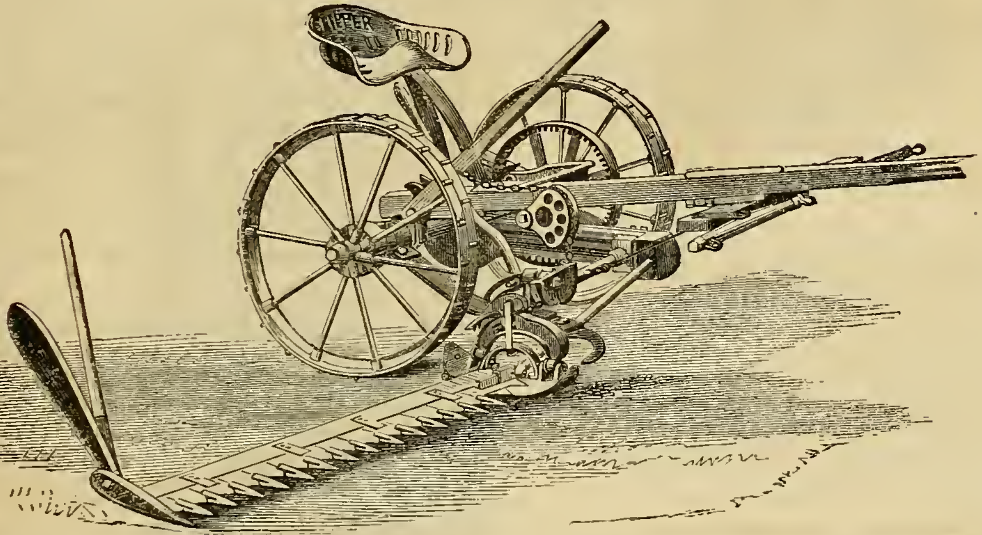
Henry Kinsey exhibited some well made vertical and horizontal steam engines, fitted with his improved "quick-speed governor," which is about the most simple form of governor that can be adopted. The arms act somewhat on the principle of bell cranks suspended by one joint pin from the elbows, and supporting a weight sliding vertically along the governor spindle upon their upper limbs, which are rounded in order to insure a rolling action between the weight and the arms where the latter rise and fall. John Warner & Sons exhibited an improved wind engine on the principle of Peill's wind engine, but having the vanes or sails shortened so as not to extend to the centre. We also notice here a good form of "noria" or chain pump, besides other useful novelties in pumps and fire engines. Messrs. Tangye Brothers exhibited several of Cameron's double-action pumps, improved by Holman; also their well-known lifting jacks, and an ingenious contrivance for drilling and tapping gas mains. Not far from this stand we noticed at work, at the stand of Riches and Watts, one of Edward's hot-air engines; also a 1 horse-power Hugon gas engine, exhibited at work, by Alfred Robinson.

Amongst the brick and tile machinery were exhibited the well-known machines of John Whitehead, of Preston, which have taken the first and second prizes; also two good machines exhibited by J. D. Pinfold, with rotatory and traversing cross cutters. The second prize has been awarded to Mr. Pinfold for his brick machine with traversing cross cutters.

Some important novelties in reapers and mowers are exhibited by Hornsby & Sons, J. & F. Howard, and the Reading Ironworks. Messrs. Hornsby's reaper is provided on the near or inner side of the platform with a lifter similar to that on the outer side, for the purpose of raising the heads of corn on the outer edge of the standing grain, which have a tendency to droop as the machine approaches, thereby preventing the heads from being cut off or damaged by the cutter.

In Messrs. Howard's improved reaper double concentric cams are employed, the one for directing the motion of the gatherers, and the other for guiding the rakes; the former being caused to drop down into the grain in order to bring it up to the cutters, and then to rise again so as to clear the cut grain on the platform, which is removed by the rakes governed by the second annular or concentric cam. The platform is hinged from the centre by a kind of drag bar, and the delivery is driven from a central shaft by a pitch chain, thus enabling light gearing to be used for actuating the cutter bar. The mower possesses also several improvements, amongst which we may point out a simple mode of lifting and varying the angles of the cutter. The "Clipper Mower," which we illustrate, exhibited by the Reading Ironworks, has many peculiarities. The pole is independent of the draught, as the tractive strain is exerted through a sliding attachment on the under side of the pole. By this system there is a tendency not only to draw the machine directly forward but at the same time to lift the shoe off the ground. The inside shoe and its attachments are so arranged that the fingers and knives can be changed from a level cut to an angle of thirty degrees while the machine is in motion. Messrs. Howard exhibited also, and obtained a prize for, their improved double-action steam cultivators, wherein by a novel arrangement of the tines in a <-form the draught is greatly diminished. We also noticed two of Bulstrode's patent snatch block slings, whereby the anchor man can, without any assistance, detach and move forward the snatch block whilst the implement is traversing the field. This firm also exhibit a useful three-row turnip harrow, adaptable to any width or furrow. Their horse rakes, with patent leverage, of which several are exhibited by the same firm, are well worthy of notice. Messrs. Howard also exhibited their safety boiler, wherein the bottom tubes extend longitudinally over the furnace in lieu of transversely, as first constructed, and are fitted with screwed end caps for facilitating cleaning when required.

Fig. 5.



Wm. Tasker & Sons exhibited a new windlass, with ropes, rope porters, and other steam-cultivating appliances, to be drawn by an ordinary engine; also a new implement for scarifying and drilling corn and other seeds, harrowing and rolling, in one operation, the invention of Mr. Robert Higgins, of Potten, Hants; also straw elevators and combined portable thrashing machines, with their well-known improvements attached.

A first-rate display of wood-working machinery was made by Charles Powis & Co., including their combined machine, or universal joiner, which in many cases will be found a most useful assistant.

As at Bury St. Edmunds last year, the most attractive feature of the show was the stone-breaking machine exhibited at work on the hardest granite by Mr. Marsden. This gentleman also exhibits another machine suitable for first breaking and then rubbing or triturating fine ores and minerals, the oscillating jaw having a rubbing action combined with it, which granulates, without absolutely reducing to fine powder, the materials submitted to it. For the reduction of flint or emery stone, in the manufacture of sand paper, this machine will be invaluable.

G. R. Cowen, of Nottingham, exhibited some good specimens of steam-engines, including two of Hall's rotatory engines, of 8 and 2 horse-power respectively. These engines have now been some time before the public; and from their compactness and simplicity, and the high rate of speed at which they can be run, are well worthy the attention of those who require small and powerful prime movers.

We noticed several excellent press wheel rollers or clod crushers for steam power, also some useful wrought-iron adjustable water ballast road or park rollers, at the stand of Arnies, Barford, & Co.; also a large and useful steam cooking apparatus, comprising a vertical wrought-iron steam generator of 2 horse-power, fitted with self-feeding apparatus, and combined with two steaming pans capable of containing 9 bushels of roots, and with two 60-gallon double-cased boiling pans. We also remarked a convenient and useful cow-feeding appliance exhibited by Cottam & Co., of Winsley Street, Oxford Street.

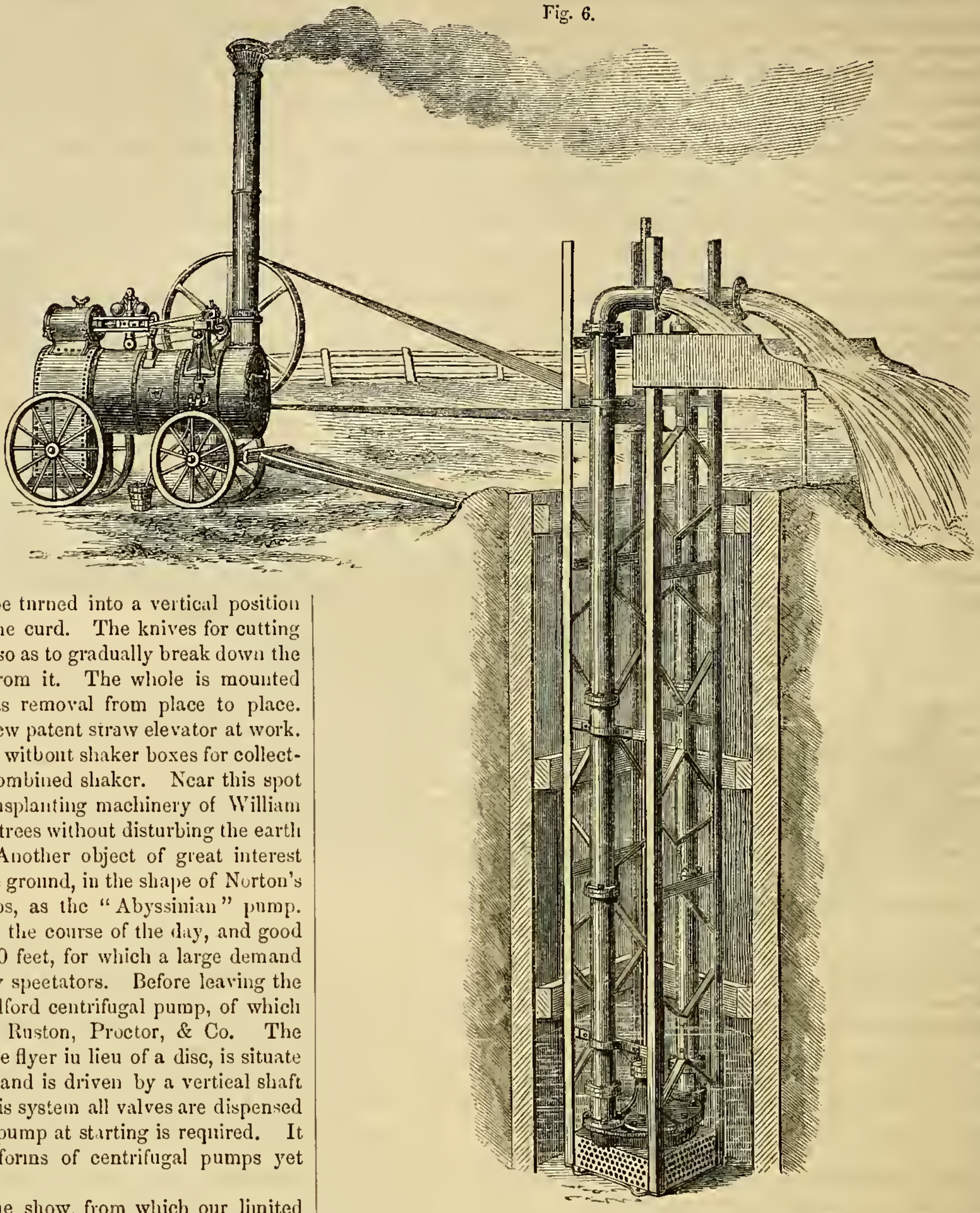
William Barton, of Boston, exhibited an admirably arranged circular-front cooking apparatus. In plan the range is semicircular. The boiler and oven are rectangular, their contiguous faces being at right angles to one another, leaving a triangular space for the grate, which is diminished in size by two fire lumps on its two inner sides. The boiler projects further to the rear than the oven, and has a box opening with covering rising above the hot plate. The flame and smoke, passing over both boiler and oven, descends at the further side, and then passes underneath, uniting in a circular smoke flue which ascends at the back of the range. The draught may be cut off at either side by a small valve, when it is required to direct all the heat to one vessel. The bottom of the grate can be raised and lowered at pleasure, carrying with it the cinder sifter and tray. The movement is simply effected by a keyed winch turning a cog and ratchet. The front fire bars can be taken out or replaced as required. Underneath the hearthstone is an ashpit capable of holding a week's consumption; and from this ashpit runs a dust flue, which ascends the back of the range and joins the smoke pipe, the ventilating pipe from the oven being carried into the same flue. Immediately above the level of the hot plate the smoke flue is formed of a small, hollow, truncated, conical boiler, which is connected by means of two pipes with a cistern at any required distance from the range. The water in this boiler is partly heated by a steam pipe from the box opening of the large boiler, which, passing spirally through it, reaches to the supply cistern, the water in which it warms. Another steam pipe, which, as well as the first, is provided with a stop-cock, communicates with the two steamers and lining of the hot closet seen in the engraving. The smoke ascends in an iron pipe 6 inches diameter placed in the chimney to a height, if possible, of 16 feet above the range, and the kitchen is ventilated and smells carried off in the chimney itself, which can thus be left open over the hot plate. The boiler tap is fixed 5 inches above the bottom of the boiler, so that all the water can never be drawn off.

Mr. W. Nicholson, of Newark, had an extensive show of haymakers, for which he is now celebrated; also some improved land rollers of large diameter and consequent light draught in proportion. The Beverley Iron and Waggon Company exhibited a useful two-horse mower and a one-horse reaper with manual delivery; also several of their famous carts and waggons. William Crosskill & Sons still maintain their well-earned reputation for carts and waggons, a large and excellent show of these articles being on the ground: they are evidently the very perfection of design and workmanship. Richmond & Chandler exhibited several of their improved chaff cutters, the merits of which are now generally well known.

Amongst the appliances for the dairy which deserve notice, we may mention the simple and well-made barrel churns exhibited by Mr. Robert Tinkler, of Penrith. These churns have now become well known, but the inventor has introduced some recent improvements in the form and arrangement of the beaters (illustrated and described on page 156), which tend considerably to increase the rapidity of action of the churn, whilst affording facility for the ready removal of the butter. A large cheese-making machine was exhibited by Mellard, Southwell, & Co of Rugeley. This machine performs the several operations of cutting, gathering, pressing, and vatting the curd. It consists of a circular press provided with taps mounted on an iron frame, and turning upon an axis, so that it may be tilted at pleasure to pour off the whey. Above the pan an improved system of leverage is provided for actuating a pressing plate or sinker. The sinker is elevated by a chain and counterweight, and when raised may be turned into a vertical position to afford greater facility of access to the curd. The knives for cutting the curd are constructed and arranged so as to gradually break down the curd without separating the cream from it. The whole is mounted on travelling wheels for facilitating its removal from place to place. James Hayes & Sons exhibited their new patent straw elevator at work. These elevators are made either with or without shaker boxes for collecting the waste corn which escapes the combined shaker. Near this spot we noticed the large and powerful transplanting machinery of William Barrow & Son, for the removal of large trees without disturbing the earth immediately surrounding the roots. Another object of great interest was to be met with at this corner of the ground, in the shape of Norton's tube wells, now better known, perhaps, as the "Abyssinian" pump. Several wells were sunk on the spot in the course of the day, and good water obtained at a depth of about 20 feet, for which a large demand was immediately created by the thirsty spectators. Before leaving the subject we ought to mention the Woodford centrifugal pump, of which we give an engraving, exhibited by Ruston, Proctor, & Co. The rotatory apparatus, consisting of a single flyer in lieu of a disc, is situate in a case at the bottom of the water, and is driven by a vertical shaft from an engine on the surface. By this system all valves are dispensed with, and no priming or filling of the pump at starting is required. It is undoubtedly one of the simplest forms of centrifugal pumps yet constructed.

Before concluding our notice of the show, from which our limited space reluctantly compels us to omit many articles deserving of commendation, we may notice briefly a few miscellaneous exhibits which attracted our attention. Amongst these may be mentioned a diamond millstone dressing machine in operation, invented by a Mons. Golay, of Switzerland, and exhibited by Bryan, Corcoran, & Co., of Mark Lane; also some pulley blocks by Jonathan Pickering, wherein, by an ingenious arrangement of sun and planet motion contained inside the block, a powerful lift is obtained, and the load sustained without slipping. The lifting chain is provided with a hook at each end, so that no lowering is required for a fresh load. Amongst the numerous elegant horticultural appliances exhibited we particularly noticed the fern and floral arboretes, modelled from nature in terra cotta, exhibited by William Hudspith, of South Tyne Works, Haltwhistle, Northumberland. These articles represent hollow trunks of trees and root-work, the cavities of which are filled in with earth for the growth of ferns and other plants, the effect produced being exceeding pretty and novel. Lastly, we have to notice the ingenious fruit-tree and plant protectors, exhibited by W. E. Rendle, of Welbeck Street, Cavendish Square. They consist of earthenware troughs covered with glass, and provided, if intended for strawberries or other plants, with apertures in the bottom, through which they grow inside the protector, which forms, in fact, a species of diminutive greenhouse. When intended for the protection of wall fruit, the troughs are nailed to the wall, and the fruit-bearing branches are laid into or trained along them, the glass effectually protecting the fruit from injury of any kind.

Fig. 6.



THE PATENT LOCOMOTIVE ENGINES OF ROBERT T. FAIRLIE, ESQ., C.E.

(Illustrated by Plate 5.)

Until Mr. Fairlie took out his patents for improvements in locomotive engines, no other method occurred to our engineers for adapting the engine given to us at the very commencement of our railway experience by Stephenson, Blenkinsop, and Braithwaite, to the ever increasing demands of our traffic, than by gradually increasing their weight, which increase had either to be made in the length or height of the machine. The increase in the length, which means the wheel base, has long reached its maximum for safety; especially as engineers are now becoming daily more familiar with the necessity of making *railways to suit the circumstances* of the country to be traversed, instead of compelling, at any cost, circumstances and the country to *suit the railways*, as in the Stephenson time. This change naturally leads to more sharply curved lines, and lines with steeper gradients—in fact, to constructing cheap lines following the configuration of the country, instead of the expensively constructed straight and level lines of twenty years ago. The limit, however, to this method was reached when the ordinary type of engine became so heavy on the usual six wheels as to be found so destructive to the permanent way, that rails, even of steel, were found to last in some places but a few months. It was therefore necessary that something should be done to change the condition of the locomotive, to enable these lines to be worked economically; and Mr. Fairlie has grasped the whole question fundamentally and in the most practical form. The limit of load which it is possible for any one pair of wheels to carry economically being reached, it follows that, in order to obtain greater power than the locomotive at present in use can afford, we must employ engines with a greater number of coupled wheels. But it has been found in practice that coupling more than three pair of wheels together does not answer in the long run, so that we shall be compelled to arrange the wheels in two or more groups, each group driven by independent engine power.

The Fairlie engine, of which we this month give a Plate, is designed to meet the difficulties we have above alluded to. It has twelve wheels 4 feet in diameter, arranged, as shown, in two groups, each group being independent of the other, and being driven by a pair of cylinders 18 inches in diameter with 24-inch stroke. Each bogie has a wheel base of 8 feet 6 inches, and this length is practically the rigid wheel base of the engine; the great length of the total wheel base, or the distance between the centres of the extreme axles of the two groups, in no way interfering with the engine readily traversing the sharpest curves. The total wheel base being 32 feet 6 inches gives great steadiness to the engine, whilst, as will be seen, it does not interfere with its flexibility. The boiler is carried in a cradle or carrier frame, which is in turn supported on the two bogie frames. All strains, &c., are taken up by the carrier frame; the boiler merely has to supply steam to the cylinders. The arrangement is, in fact, such that, could steam be supplied to the cylinders from any other source than the boiler, the engine would be perfect in every respect, if we leave the weight of the boiler, which is necessary for adhesion, out of the question. The tractive force of this engine with a cylinder pressure of 100 lbs. per square inch = 33,400 lbs., which is equivalent to a gross load of about 390 tons up a gradient of 1 in 25, at a speed of ten miles per hour.

Several engines of this class are now in use. They are extremely easy, we are informed, on the road; and as the whole weight of the machine is equally distributed over a large number of wheels, the wear and tear both of the engine and the permanent way are consequently reduced to a minimum, while they adapt themselves with facility to the curvature and inequalities of the road without any of that grinding and jarring between wheel flanges and rails so common with locomotives of the ordinary type. The fuel and water being carried on the engine itself, the necessity for a tender is dispensed with, and the whole weight carried is made available for adhesion or grip on the rails. The bogies being free to swivel on their pins, each engine can radiate independently of the other; so whilst passing round even an S curve each bogie can accommodate itself to the direction of the curvature without in any way interfering with the action of the other. The boiler has two barrels, each 13 feet long by 4 feet in diameter, these barrels springing from a central fire-box casing 10 feet 6 inches long. The barrels contain 352 tubes, 2 inches in diameter inside, and the boiler has altogether a total heating surface of 2550 square feet—an ample allowance. The grate surface is 32 square feet. It will be seen by referring to the Plate that both the regulator and the reversing gear are arranged to be worked from either side, so that the objection urged by some against this class of engine, that the engineman and fireman could not assist each other, if need be, is done away with.

The steam pipes, as shown, pass from the steam dome in the usual manner to the bogie frames near the cylinders, where they are connected by T-shaped pipes. The arms of these T-pipes are curved to arcs struck from the centre of the bogie pin; and they are free to slide in the ends of other pipes, also curved, which are attached to the cylinders or steam chests. The last-mentioned pipes are fitted, as shown, with stuffing boxes.

The steam pipes of the first engines constructed on this system gave considerable trouble; but this difficulty has been satisfactorily got over by the arrangement shown in the engraving.

By making the fire-box in the centre of the engine, and having a boiler barrel running in either direction, great tube surface is obtained; and the fire-box also may be made of any desired size, as the bogie frames may be placed any distance apart that may be required. The heaviest parts of the boiler are thus also placed nearest to the centre of gravity of the whole system.

That a complete revolution must take place in our present locomotive practice there can be no doubt. The locomotive of to-day is the same in all essential particulars as when it left the hand of Stephenson; we have only gone on increasing its size and weight. We cannot, with economy and safety, enlarge the present type of engine: it must be completely remodelled; and the engine which combines great steam-generating and cylinder power, and great adhesive weight with flexibility and safety, must be the engine of the future.

MECHANIC'S LIBRARY.

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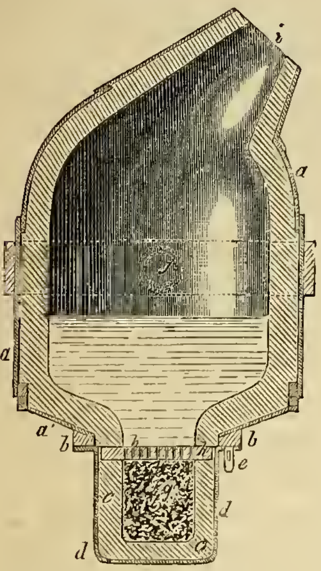
RECENT PATENTS.

MANUFACTURE OF IRON AND STEEL.

HENRY BESSEMER.—*Patent dated 31st December*, 1867.

IN the specification of a patent granted to Mr. Bessemer, and dated the 12th day of February, 1856, there is described the conversion of molten crude iron, or of remelted pig or finery iron into steel, or into malleable iron without the use of fuel for reheating or continuing to heat the molten iron; such conversion being effected by forcing into and among the particles of a mass of molten iron currents of air or gaseous matter containing, or capable of evolving, sufficient oxygen to keep up the combustion of the carbon contained in the iron till the conversion is accomplished. This process is now well known as the "Bessemer process;" one method of conducting it is to place beneath the molten iron a perforated case, capable of bearing a high heat, and containing a solid matter, such as nitrate of soda, which gives off oxygen on being heated. The heat of the molten iron causes the nitrate, or other matter, to liberate oxygen, which forces its way through the perforations in the case, and it issues into and amongst the particles of the molten iron, as when air is forced through the tuyere pipes in the ordinary way of conducting the Bessemer process. When solid matters are used to generate the oxygen, as above stated, it is advantageous to use a converting vessel, like that which is usually employed in conducting the Bessemer process; that is to say, a vessel mounted on trunnions, and with a mouth or opening to receive and discharge the metal, and give exit to the gases passing away during the conversion, and also with an aperture at the bottom. This aperture usually receives the tuyere box, which covers it when the vessel is at work and air is blown through the tuyeres, but, when solid substances are to be used, the tuyere box is replaced by a case or chamber lined with refractory material. This case or chamber is filled with nitrate of soda, or other material capable of evolving oxygen, and is closed at the top with a perforated fire-tile, or, it may be, with a slab of refractory stone. The case is made of such dimensions that the area of the surface of the nitrate or material is but small, as compared with the area of the principal horizontal section of the metal in the converting vessel. In this way the intensity of the action is modified, and the rapid scoring action which would result from the passage of the gas between the metal and the sides of the vessel is prevented. Also, in order to render the action more regular than it otherwise would be, the nitrate of soda or other material is fused and cast into the case or chamber in which it is to be used, and there allowed to solidify. The melted metal is then effectually prevented from acting on more than the upper surface of the cast block of nitrate or material, or the fused nitrate or material may be cast into separate moulds, and afterwards placed in the cases or chambers. Or, in some cases, the nitrate or material is moulded into blocks under heavy pressure before inserting it into the case or chamber, and the violence of the action of the nitrate or material on the iron may be reduced to any desired extent by mixing dry clay or other inert matter with the nitrate or material.

Fig. 1.

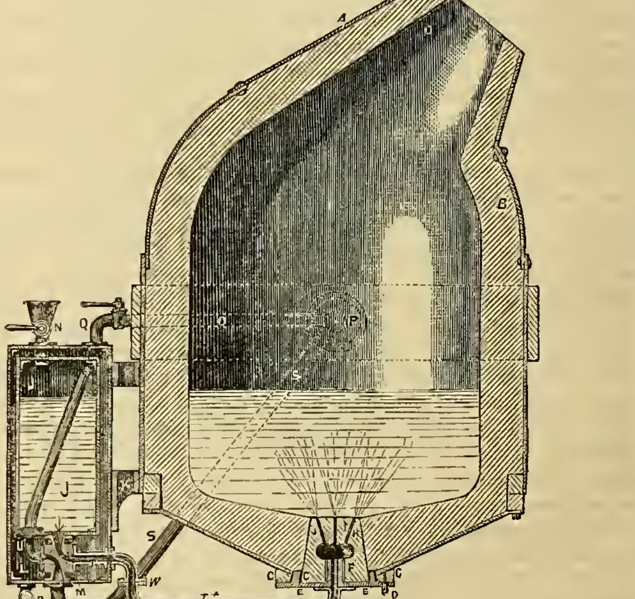


In order that the way in which the case or chamber containing the nitrates or other material capable of yielding oxygen gas is applied to converting vessels, such as are generally employed in the Bessemer process, may be fully understood, a vertical section of an apparatus so arranged is shown at fig. 1 of the engravings. At the lower part of the vessel, *a*, which is similar to the vessels usually employed in conducting the Bessemer process, a ring or hoop of iron, *b*, is fixed to the plates, *a*, which form the lower part of the vessel; the case or chamber, *d*, for holding the nitrates or other material is provided with a flange at its upper edge, which is secured to the vessel by a series of slotted studs and cotters, one of which studs is shown at *e*; the case or chamber is lined with fire-brick, fire-clay, ganister, or other suitable refractory material, as shown at *c*. When the nitrate or other material shown at *g* is put into the case, the perforated cover or tuyere plate, *h*, composed of fire-brick or Ransom's concrete stone, is put on, and the case will then be in a condition ready for use. When, however, the nitrate or other material is fused and cast into the case or chamber, *d*, and has become solidified therein, the use of the tuyere plate may be dispensed with, as the metal will act on the upper surface of the nitrate or other material, and fuse it gradually, and not float it upwards in the way that loose crystals of the nitrates would be carried up if tuyere plates were omitted. Before operating on the crude iron, it is preferred to heat the vessel, which may be effected by securing an iron grating to the bottom of the converting vessel by means of the slotted studs, *e*. On this grating a fire can be made, the products of combustion escaping by the mouth, *i*, of the vessel. When the vessel has been heated sufficiently, the grating may be removed, and the case or chamber, *d*, may be secured in place, as shown in fig. 1. A little "slip," or mixture of clay and fine sand in a creamy state, is put around the edges of the tuyere plate, *h*, so as to secure a good joint; after which the vessel may be turned on its axes (one of which is shown by dots at *j*) into a position to receive the molten crude iron to be operated upon, so that the whole of the metal from the melting furnace may be run or poured into the vessel before any action of the nitrates takes place. The movement upward of the vessel thus brings the whole of the metal simultaneously into a position to be operated on. The fluid iron enters the tuyere holes, and coming in contact with the nitrate or other material, rapidly generates oxygen gas, which passes upwards from the tuyere plate in numerous streams through the fluid metal, in the same manner as air passes upwards from the tuyere holes in the ordinary Bessemer process. The oxygen will decarburize the crude iron and convert it into malleable iron or steel; after which the products may be discharged from the mouth, *i*, of the vessel by turning the vessel on its axes, as usually practised.

Also according to this invention, when either nitrate of soda or nitrate of potash, or other easily fusible matter, is employed, which yields oxygen in coming in contact with fluid iron, and purifies or decarbonizes the same, the nitrates or other matters are brought into a fluid state in a suitable vessel before they are brought in contact with the molten iron, and such fused nitrates or other matters are introduced in jets or currents which are forced through small openings or tuyeres into the fluid metal; the force with which they are injected being such as will prevent the fluid iron from entering the tuyeres, or the chamber containing the aforesaid fluid nitrates or other matters. It is preferred to fuse these matters in an iron vessel provided with a jacket for the circulation of superheated steam or hot air, one or more fire-clay tuyeres are inserted in the lower part of the converting vessel, which tuyere or tuyeres are connected by a short pipe with the vessel containing the fluid matters before-named. The passages leading into and through the tuyeres may be heated by passing superheated steam or hot air through them previous to admitting thereto the fluid nitrates or other matters. The emission of the superheated steam or hot air will serve to exclude the fluid metal from the tuyere openings until it is desired to introduce the fluid matters into the vessel; and also after the whole of the fluid nitrate or other matters have been injected, the steam or air will again pass, and thus prevent the iron from entering the tuyeres or passages. In order to force these jets of fluid into the molten iron, superheated steam or hot air under sufficient pressure are employed to act on the surface of the said fluids, the mouth of the vessel containing them being closed by a valve for that purpose.

When fluid matters are so employed to refine, purify, or decarbonize any molten iron, it is preferred that the vessel containing the iron should be of such form as will admit of a much greater depth of fluid metal in proportion to its diameter than vessels usually employed in the Bessemer process; but this increased depth of metal is not essential to the success of the process, but is to be preferred in constructing new apparatus. Such vessels may either be movable on trunnions, or they may be fixed cylindrical or other-shaped vessels; but it is preferred to employ vessels mounted on trunnions usually called tipping vessels, such as are generally employed in the Bessemer process. Vessels that are now in use for that process may be readily adapted to the use of fluid nitrates in lieu of atmospheric air, as will be readily understood on reference to fig. 2, which represents a vertical section of a Bessemer converting vessel in different positions, with the apparatus necessary for using fluid nitrates attached thereto.

Fig. 2.



The converting vessel, A, is constructed of plate iron, and has a lining of ganister, B. At the lower part of the vessel there is a hoop of iron, C, from which slotted studs, D, project, and by means of which the tuyere plate, E, is secured to the vessel. This plate has a tubular part, F, and an inclined ring, G, projecting from its upper surface. A block or tuyere of burned fire-clay, H, is fitted into the inclined ring, G, and rendered air-tight by running in some Portland cement or plaster. The central part of the tuyere, H, is made hollow, and several small openings, I, converge from it, as shown, for the purpose of distributing the fluid nitrates or other materials in small streams through the fluid metal. At the back of the converting vessel the chamber, J, is fixed; it is surrounded by a jacket, L, which also incloses the four-way cock, M, the handle of which is external to the jacket, and therefore not seen in the engraving. K K are brackets by which the jacket, L, is connected with the casing of the converting vessel. Before the apparatus is employed to convert the crude metal, a fire may be made in the vessel, a blast of hot air being propelled through the tuyere block, G, for the purpose of keeping up the combustion of the fuel. Meanwhile the nitrate of soda, or other material yielding oxygen gas, is put into the chamber, J, through the funnel and cock, N, which is then closed. Highly heated air is passed by or through the axis of the vessel (shown by dots at P), and the air is conveyed by the pipe, Q, into the jacket, and allowed to blow off through the cock, R. This air is heated to a temperature sufficiently high to melt or fuse the nitrates or other materials contained in the chamber, J; or their fusion may be effected in other vessels before they are supplied to the chamber, J, where they are then retained in a fluid state by the hot air passing through the jacket. Whilst the metal is running in, a current of hot air is employed to heat the pipes and tuyere block through which the fluid nitrates are to pass, the air also serving to prevent any of the molten iron from entering the tuyeres. The air for this purpose is conveyed from the axis of the vessel by the pipe, S, passes through the four-way cock, M, and pipes, T and T′, into the tuyere block, from which it escapes by several small passages. As the mouth, O, of the vessel is turned upwards the tuyere block, H, descends; and just as it is about to be immersed beneath the surface of the molten iron, the four-way cock, M, is reversed; the vessel is then turned up into the position shown.

By the reversal of the four-way cock, the air under pressure no longer passes through the pipes, T and T′, into the tuyere block, but finds its way through the pipe, U, into the upper part of the chamber, J, and there pressing on the surface of the molten nitrate or other material, forces it through the four-way cock and pipes, T and T′, and through the several tuyere openings into the fluid metal. When the whole of the fluid has been discharged, the air under pressure will follow through the same passages and exclude the metal from the tuyere block, until the vessel is turned down and its contents discharged. If the nitrate, or other material yielding oxygen gas, be used in such quantity as only to partially decarburize the crude iron, the passage of air through the metal, after all the fluid nitrate has been discharged, will not only complete the decarburization to the desired extent, but it will increase the temperature of the metal. This increase of temperature will be still more readily effected if some fluid spiegeleisen, or other carburet of iron, be added at the time; that is to say, after all the nitrate or material has been injected.

In order that the removal of an old tuyere block, and the supply of a new one, may be effected readily, a joint is made in the pipe T′, at W. The elbow pipe, T, has a dovetailed ring bolted to it, and the pipe T′ has a corresponding dovetailed flange fitted into the ring, and capable of moving within the dovetailed ring, so that whenever the flange of the pipe T′ is unbolted from the tuyere plate, E, it may be moved on the joint, W, out of the way, and thus admit of the removal of the tuyere plate from the vessel. Such vessels may either be movable on trunnions, or they may be fixed cylindrical or other shaped vessels. Usually such a proportion of nitrate or material in relation to the quantity of crude or cast iron operated on is employed, as to convert the metal at once into malleable iron or steel. In some cases, however, it may be convenient to employ a smaller proportion of nitrate or material, and to leave the metal in the form of a readily fusible cast iron, but of improved quality; and the cast iron may be afterwards converted by the ordinary Bessemer process, or otherwise employed.

It is well known that there are many gradations of quality, or degrees of decarburization, between what is usually called mild steel and that quality of metal which is usually termed cast iron; and it will be obvious that the decarburization of the metal may have any range between these limits, depending on the quantity of oxygen producing material employed, and the quantity of carbon originally contained in the crude iron, and therefore that the metal may be discharged from the vessel, after treatment with the nitrates or other material, in such a state of decarburization as may best adapt it to the uses or after processes for which it may be required.

Nitrate of soda or nitrate of potash, or chlorate of soda or chlorate of potash, may be carried into and amongst the molten iron by means of a current or currents of air introduced below the surface of the metal, as is suggested in general terms in the specification of the said former patent, as also in that of another patent granted to Mr. Bessemer, dated 31st May, 1856. In some cases, however, it is desired, in place of converting the metal in part by the air introduced, and in part by the nitrate or chlorate which it carries with it, to effect the conversion entirely by the nitrate or chlorate; a current or currents of an inert gas, such as carbonic acid gas, or steam or vapour, is employed to carry the powdered nitrate or chlorate into the converting vessel amongst the molten metal. For this purpose it is preferred to reduce the nitrates or other materials capable of yielding oxygen gas of a fine powder, having first baked them, so as to deprive them, as far as possible, of water. The powder may be admitted to the pipes, which convey the gas into the metal, by a feeding screw or other known contrivance for regulating the supply of powdered or granulated materials. The gaseous matters employed for conveying these powdered materials into the molten metal may be obtained by passing air or steam, under sufficient pressure, through a close vessel lined with fire-brick, and containing coke or other fuel in an incandescent state, as is well understood; or the gases may be generated by any other known and efficient means.

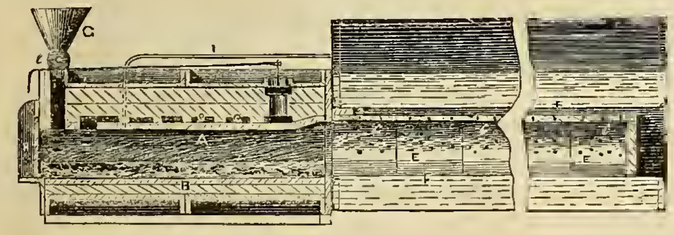
FURNACES.

Francis Chamberlain, *of Bredecot Court, near Worcester.—Patent dated 6th January*, 1868.

This invention relates to improvements in steam boiler and other furnaces, whereby a more perfect combustion of the fuel, and consequently prevention of smoke, is effected. When applying the invention to a steam generator the improved furnace is constructed on the exterior of the boiler. At the front end of the top of the furnace is placed a feeding hopper, which extends into the interior of the furnace, for the purpose of supplying the fuel continuously thereto, or if desired, the fuel may be supplied through the furnace door. The fuel preferred to be employed is small coal, which on coming in contact with the heated air in the furnace is instantly ignited, and the heated products of combustion then pass over a large surface of incandescent fuel (the residue of previously gasified coal) into a heat magazine placed in the tube of the boiler for the purpose of generating steam, or for other heating purposes. In order to facilitate the combustion of the fuel, air is admitted into an air-heating chamber or flue situate over the combustion chamber, by means of a regulating valve fitted at the hottest end of such chamber, the air being heated in traversing from the boiler end of the air-heating chamber or flue to the front or feeding end of the combustion chamber, where it passes through perforations into the combustion chamber. The admission of cold air tends to keep the arch or crown of the furnace cool, whilst at the same time the air is heated before entering the combustion chamber. When desired to increase the draught a jet of steam is admitted into the gases, and forces them into the incandescent fuel. By this construction of furnace fire-bars are dispensed with, and by constructing the furnace outside the boiler a greater heating surface is obtained than when the furnace is constructed within the tube of the boiler. The heated products of combustion pass into a heat director or accumulator, composed of fire-clay built in the tube of the boiler, which accumulator is quickly raised to a high temperature, the heated currents escaping through perforations direct against the plate of the boiler. A suitable space is left between the plates and the accumulator for the purpose of supporting the draught. In places where space is limited a feeding hopper may be placed in front of the boiler, and at the lower end of such hopper is placed a step grate or a vertical or nearly vertical grate, supported above a horizontal dead plate, a space being left between the bars and the dead plate for the purpose of removing the waste or residue from the fuel. Air for supporting combustion passes through the vertical grate and through the incandescent fuel, the hopper being self-acting, and the heated products of combustion pass into an accumulator, as before described with reference to the first arrangement. The vertical bars may be arranged to turn on hinges to facilitate the clearing out of the dust from the accumulator.

Fig. 1 of the engravings represents a longitudinal vertical section of the improved furnace, as applied to a Cornish boiler; fig. 2 is a corresponding plan of the same, showing the furnace in horizontal section. A is the combustion chamber, which is constructed of ordinary brickwork lined with fire-bricks, and is situate outside the front end of the boiler. The fuel rests upon a solid bed or surface, B, of fire-brick, in lieu of upon ordinary fire-bars, and the roof of the chamber is arched. Through this arched roof, and at or near the front end of the combustion chamber, are made a number of apertures, *a a*, communicating with the hot-air chamber, or zig-zag air flue, C, constructed immediately above the arched roof of the combustion chamber, the air being admitted thereto through a regulating valve, D, situate at or near the rear end of such chamber or flue, so as to be over the hottest part of the combustion chamber, A. The back end of the combustion chamber opens direct into one or more heat directors or accumulators, E E′, situate inside the flue or flues, F F′, of the boiler, such heat directors or accumulators being so placed inside the flues as to leave an annular or nearly annular space, *b b′*, between the exterior of each accumulator and the interior of the flue in which it is placed. These heat directors or accumulators consist of long fire-clay tubes, closed at the rear end, and perforated on their upper sides with numerous small holes, *c c*, through which the gases from the fuel burn in the form of jets in close proximity to the surface of the flues, as will be clearly understood on referring to fig. 1 of the engravings. As the accumulators, E E′, soon attain a highly elevated temperature, and as they extend along the entire length, or nearly so, of the boiler flues, it follows that a considerable amount of heat will be stored therein, and radiated uniformly to the surrounding sides of the flues, whilst at the same time the numerous perforations in the accumulators serve as directors of the flame jets, causing them to impinge equally against the sides of the flues from end to end thereof.

Fig. 1.



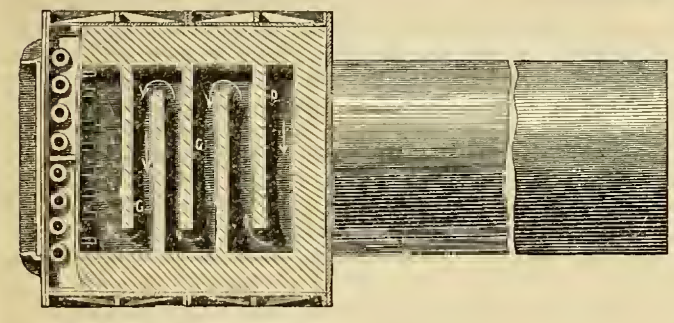


Fig. 2.

The fuel employed consists of small coal, which is fed into the troughs or hoppers, G, and descends thence by its own gravity along the several vertical passages, *d d*, into the front end of the combustion chamber, A, a regulator, *e*, being fitted to each passage, if desired, for the purpose of controlling or shutting off the supply of fuel to the furnace. In some cases the fuel may be supplied in the ordinary manner through the open fire-door, H. The air for supporting combustion enters direct from the atmosphere into the air flue, C, its ingress being controlled by the regulating valve, D. On turning the zig-zag flue or passage, the air becomes highly heated, and finally enters the front end of the combustion chamber by the apertures, *a a*. I is a steam jet pipe, which may be employed for directing a jet or jets of steam into the combustion chamber when more than the ordinary draught is required. The products of combustion, after having acted upon the boiler flue or flues, may return by external side flues, or be otherwise conducted to the final outlet or chimney, according to the mode of setting the boiler, which forms no part of the present invention.

Fig. 3.

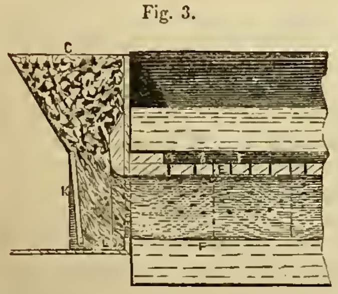


Fig. 3 represents a sectional elevation of a portion of a Cornish boiler, showing the arrangement of furnace which may be applied thereto in cases where space is limited.

In this modification the feeding hopper, G, is placed close against the front of the boiler, and at the lower end and in front of this hopper there is fitted a vertical, or nearly vertical grate, K, supported a little above the dead plate, L; the incandescent fuel, which may be used of the ordinary size, is principally contained between the grate and the boiler front, a small portion being allowed to enter the flue or flues, F. Instead of the vertical bars a step grate may be used. Within these flues are disposed heat directors or accumulators, E, constructed and operating in precisely the same manner as hereinbefore described with reference to figs. 1 and 2. In this arrangement the air for supporting combustion enters the furnace through the vertical grating, K. Although the said invention is only represented as being applied to steam boilers or generators, it is obviously applicable to other furnaces for heating purposes.

MANUFACTURE OF IRON AND STEEL.

John Allcock Jones, *of Middlesborough—Patent dated 16th January*, 1868.

This invention relates to certain improvements in the manufacture of iron and steel from cast iron, pig iron, or refined metal. The invention is practically carried out as follows:—The cast iron, pig iron, or refined metal is first puddled in a puddling furnace of the kind at present in use, or a rotary puddling furnace, or a furnace where the process is carried on by mechanical puddling. The object of the puddling is by the aid of clean or pure cinder, or oxides of iron or oxide of manganese, or other oxidizing agents, together with the act of puddling, or by the act of puddling alone, so to cleanse the pig or cast iron or refined metal from sulphur and phosphorus and other impurities as to make it fit for melting into cast steel. After the pig or cast iron or refined metal has been melted in the puddling furnace, as at present done, or melted in some other furnace, such as an air furnace or cupola, and thence run into the puddling furnace, thus saving time and fuel, it is boiled in the usual manner, and a portion of the cinder allowed to run from it. It is then balled into balls and removed from the furnace and plunged hot into water, if desirable; or it may be removed in the shape of convenient lumps. It is desirable that these balls or lumps should be brought out "young," that is, with as much carbon in them as is possible at that stage of working, as much carbon in them as to render it impossible to have them hammered and rolled into wrought iron or puddled steel in the usual way. It obviates to some extent the necessity of adding carbon, in the shape of cast iron or other carbonate, to the melting mass. The balls or lumps having been broken into fragments or not, as may be desirable, are placed either hot or cold in the hearth or receptacle of a steel-melting furnace as at present constructed for the melting of steel on the open hearth, or in other furnace suitable for melting the balls or lumps into steel; or they may be melted in a crucible, such as those at present used for steel melting, or a crucible capable of holding a much larger quantity. In place of preparing the iron into balls or lumps, as before described, it is sometimes treated in the following manner, which is found to answer well:—After it has been melted it is puddled for a short time; but in place of carrying on the process so far as to get the cinder boiled over the foreplate, and thus preparing it for being lumped or balled, the crude metal is allowed to settle to the bottom of the furnace, and then all or as much of the cinder as will run from it is tapped or removed. The crude iron is taken away or transferred from the bottom and melted into steel, as is done with the lumps or balls, or it is taken at any of the intermediate stages between the melting and balling of the metal. By thus treating it a material with a higher percentage of carbon is obtained, and by analysis it is found that the mass holds about 1 per cent., and the balls or lumps about 0·8 of carbon; but if the balls or lumps are not brought out young, the quantity of carbon will be less. In order that others may fully understand how steel is made from the broken puddled balls or lumps or crude metal, according to this invention, the process may be described as follows:—When the receptacle in which the steel is melted is in the hearth of a gas furnace, such as Siemens' furnace, or any other furnace capable of giving sufficient heat for the steel to be kept in a liquid state, the broken fragments of the balls or lumps, or the crude metal before referred to, are made red or white hot in a furnace separated from the steel furnace, or in a chamber connected with the steel furnace, and introduced from thence in loads of say from 1 to 5 cwt., or thereabouts, to the hearth of the steel furnace. When this has been melted a further supply is introduced, and so the process is continued until the furnace is sufficiently charged. As the loads continue to melt into steel there will arise a cinder to the surface of the steel, which will act as a protective covering and protect it from oxidation; and if this cinder should be excessive, as the process continues a portion of it may be tapped off. A bath of slag, such as blast-furnace slag, may be first placed on the hearth of the steel furnace, into which the first few loads may be placed. During the period of melting into steel, if decarbonization has taken place so much as to interfere with the fluidity of the steel, a little cast iron or a carbonate not injurious to the steel may be added. The melted steel may by sampling it, that is, by inserting a ladle and removing a small portion of it, be made of any required temper. If it is too hard, broken pieces of puddled ball or lumps may be added; and if too soft, a little cast-iron may be placed amongst it. It is preferred that the broken balls or lumps, or the crude metal referred to, should contain as near to 1 per cent of carbon as is commercially possible. As the mass is being melted on the steel hearth it will continue to give out a portion of its carbon; but at each successive addition of raw material, such as the broken balls or lumps, or the crude metal before referred to, there will be added a further supply of carbon—a supply sufficient to keep the steel in a liquid condition, and to allow the steel at the latter end of the operation to contain carbon a little under in quantity what is required in serviceable cast steel. When the furnace has been fully charged, and it has been ascertained that the steel has been fully melted, and that the temper of the steel is what is required, a small quantity of spiegeleisen is added, not exceeding 5 per cent. of the melted steel, after which it is tapped into a ladle or preparatory receptacle, and thence into moulds, similar to the manner in which Bessemer steel is run. As the process is being worked out a quantity of cinder will rise to the surface of the steel, and, as this may prevent the heat penetrating sufficiently to the steel, it is desirable that a portion of it should be tapped off occasionally, and this may be done by a tap-hole arranged for that purpose; or when the hearth of the steel furnace is charged to a certain height, the cinder may be allowed to run off it as the furnace continues to receive a further charge of raw material.

The capacity of the steel furnace may be made to suit different requirements. For rail blooms a three-ton furnace will be about a suitable size; but for other purposes other capacities are more desirable. The crude metal or lumps before referred to may, if desirable, be pressed so that some of the cinder is allowed to escape from it previously to its being placed in the steel furnace.

FURNACES.

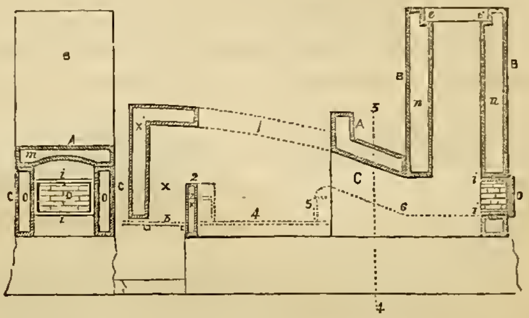
Henderson Ross, *of Pittsburg, U.S., A.—Patent dated* 21*st January*, 1868.

This invention consists in providing puddling and other furnaces with a detached metallic "clamp," furnished with a water chamber; also, in providing the furnace with a metallic fire chamber, neck or throat, and stack or chimney; such fire chamber, neck, and stack, also forming water chambers.

Fig. 1 of the engravings is a longitudinal vertical section of the improvement in the fire chamber, neck, and stack of an ordinary puddling furnace; and fig. 2 represents a transverse section of the neck of the furnace taken through at line 3–4 in fig. 1.

A represents the detached metallic clamp, which is provided with a water chamber, *m*. B is the lower part of the stack or chimney, furnished with a water chamber, *n*, and a door, D, the width of the door being equal to the breadth of the neck of the furnace. C, C are the sides of the neck, provided with water chambers, *o*, which are in communication with the water chambers, *n*, of the stack. The water chambers of the back part of the furnace, bridge wall, clamp, neck, and stack must be provided with suitable pipes for supplying them with water, and also with pipes for carrying off the heated or "waste water." The dotted lines in fig. 1 indicate the relation of the present improvements to the rest of the furnace. 1 represents the crown of the furnace; 3, represents the grate bars; 4, the bottom plate of the hearth; 5, the bosh; and 6, the form of the bottom of the neck, all of which are constructed in the usual manner, and with the ordinary materials. The back end and that portion of the crown of the furnace directly over the fire chamber and bridge wall, 2, are made of iron, and furnished with united water chambers. The upper part of the stack of the furnace may be constructed of brick or iron, with the bottom course of fire-brick lining resting on the offset; or the whole stack may be constructed with the chamber, *n*, extending from the bottom to the top of it. The door, D, is provided with a flange, *i*, for supporting and holding the brick lining. This door is used for the purpose of affording a ready opening for cleaning out the neck or throat of the furnace. The sides, C, and clamp, A, may also be so constructed as to form one part, with a single water chamber.

Fig. 2. Fig. 1.



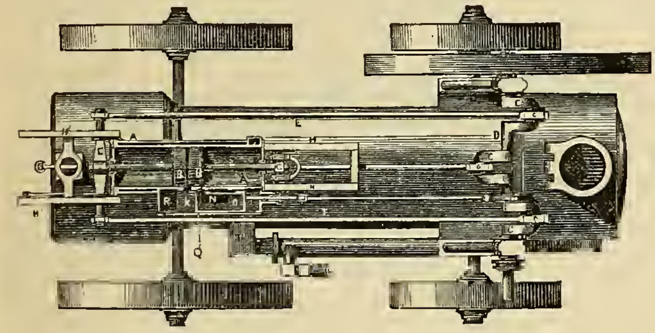
The operation of the said invention is as follows:—Water is conveyed into the different chambers at the lowest point, and carried off at the highest point. By thus supplying and carrying off the water, the chambers will always be kept full of cool water. The stack, B, with its water chamber, *n*, may be used for generating steam, which may be utilized for any desired purpose.

By this invention a saving in bricks, time, and cost of repairing the neck and fire chamber of the furnace is effected. The fire chamber and throat, moreover, are not liable to become enlarged and changed in form; hence the action of the furnace will always be uniform, which is a great desideratum, especially in furnaces used for the manufacture of iron and steel.

STEAM ENGINES.

Noah Paxman, *Jun., of Clifton Hampden.—Patent dated* 12*th December*, 1867.

This invention has for its object the more effectual application of steam to the cylinders and pistons of steam engines, whether horizontal or vertical, fixed or portable, marine or otherwise. In carrying the invention into effect two pistons are placed in the same cylinder, which pistons are driven by steam in opposite directions, the steam being caused to act upon the surface of each of the pistons instead of acting upon the cylinder covers as heretofore; the result of which will be that the entire propelling force of the steam will be utilized, and a considerable amount of power obtained. To the rod of the back piston is attached a double, and to that of the front piston a single connecting rod, which are then fixed to, and drive a crank shaft, giving motion to the other parts of the engine, the steam being admitted to the cylinder between the two pistons, and acting upon them simultaneously at each stroke when leaving the centre of the cylinder. The engraving represents a plan of a portable engine, with the cylinder and steam chest, in horizontal section. As the general arrangement of the engine forms no part of the present invention, it is unnecessary to make any further reference to it here; the description is therefore confined to the special improvements which have been introduced. A is the steam cylinder, which is of extra length, in order to obtain a suitable throw of crank; this cylinder is bolted to the boiler, or to any other convenient bedplate or support, according to the class of engine required, and has working within it the two pistons, B B′, which alternately approach towards and recede from each other. The respective cranks, C, and C′, C′, of the two pistons are formed on diametrically opposite sides of the driving shaft, D, and, if desired, the stroke of one piston may be greater than that of the other; E is a cross head secured on to the end of the back piston rod; and F, F, are two connecting rods jointed to the opposite ends of the said cross head and coupled to the pair of cranks C′, C′; G is a cross head secured to the front piston rod and coupled to the crank, C; both cross heads carry slide blocks working in the slide bars H and H′. The working cylinder is provided with one port only, which is situate at or near the longitudinal centre thereof, or at any other point which coincides with the part where the two pistons approach nearest to each other, as shown at I. This port, I, serves alternately as the induction and eduction port; it communicates directly with the steam chest, K, into which steam is admitted from the boiler by the passage, L, and steam-regulating valve, M, which may either be made as shown in the drawing, or otherwise. The eduction port or opening, N, for the escape of the exhaust from the steam chest, is here shown as being made in the bottom face, O, of the steam chest, whilst the cylinder port, I, opens into the side of the steam chest. The slide valve, P, which is made hollow, is consequently provided with two rubbing faces at right angles to each other, and has a port or opening, Q, made on one side, which communicates at certain positions of the valve with the cylinder port, I, for the free escape of the exhaust; R is an opening in the bottom of the steam chest for the admission of steam therein. The lower side or bottom of the valve is left open, so that the interior of the valve may be in constant communication with the exhaust opening, N, made in the bottom of the steam chest, and communicating directly with the exhaust pipe, T. In the drawings is represented the cylinder port, I, open, the two pistons being at the termination of their inner stroke. On admitting steam from the boiler into the steam chest by opening the steam valve, M, it passes through the port, I, direct into the cylinder between the two pistons and forces them outwards, the port being closed at any portion of the stroke as heretofore, according to the amount of expansion required. By the time the pistons have arrived at the cylinder covers the slide valve, P, will have brought the port, I, into communication with the interior of the valve through the port, Q, when the exhaust will immediately take place through the open bottom of the valve and exhaust port or opening, N, to the exhaust pipe, T. In the meantime the pistons are returned to the middle of the cylinder by the momentum of the fly wheel, and the next stroke is effected as before. The slide valve may be worked by an eccentric V, in the ordinary manner. As no steam is required to operate between the pistons and the cylinder covers, it is obvious that tight-fitting stuffing boxes may be dispensed with, or the cylinder left open at each end, if desired. The advantages which are obtained by these improvements are a considerable reduction of friction, more particularly in the bearings of the crank shaft, the strain upon which is more equalized; the vibrations of the engine are greatly diminished; reduction of condensation from the fact of the steam not coming in contact with the cylinder covers; a saving of steam, and consequently of fuel, by reason of the shortness of the steam port in the cylinder. It is obvious that two or more of such cylinders, with their pistons and slide valves, may be combined together in one engine.



LAW REPORT.

Bovill v. Cowan.—Grinding Grain.—Court of Chancery, Lincoln's Inn, July 15.—Before the Lord Chancellor. Judgment was given to-day in this case, which came on on appeal from a decree made by the Master of the Rolls last July. The suit was to restrain the infringement of the plaintiff's patent for grinding corn, which has been the subject of litigation for the last nine or ten years. The defendant in this case was the chairman of the London Association of Millers, which was formed some years ago to resist the claims of the patentee. The patent was for a process by which the accumulated hot air forced into the millstone case by the blast arising from the process of grinding was exhausted by means of a fan, which discharged the air laden with particles of flour into a porous bin or stive-room. The validity of the patent was first established in the action of "Bovill *v.* Keyworth," in 1857. Since that date an immense number of cases have been tried, embracing almost every possible form of infringement, and with uniform success to the patentee. The Manchester Association of Millers, after the trial of their best case, "Bovill *v.* Crate," which was decided against the defendant by Vice-chancellor Wood in 1867, compromised these suits, and paid damages and costs. The case of the present defendant, who is at the head of the other association, rested on this, that he used no artificial blast, and had no porous stive-room. By his decree the Master of the Rolls upheld the validity of the patent, granted an injunction against the infringement, and gave damages for past user, with costs as between solicitor and client. From this decree the defendant appealed.

Sir R. Palmer, Q.C., Mr. Little, Q.C., and Mr. North, appeared for the appellant; Mr. Grove, Q.C., Mr. Baggallay, Q.C., Mr. T. Aston, and Mr. F. Harrison, for the defendant.

The Lord Chancellor held that the specification of the patent was sufficient; that the process of the patentee was described so as to enable a workman to apply the invention; that the object of the patent was to apply a method by which the *plenum* or accumulated air forced into the millstone case might be withdrawn; that this application of an exhaust was properly claimed wherever this effect was produced by a blast; that there was such a blast within the meaning of the patent wherever the stones and case were so constructed that they caused a current of air down the eye of the stone, even although there was no fan outside the case injecting air. He held, further, that the patent was not shown to be anticipated by any other, whether English or foreign, and it was admitted to be useful. The defendant, therefore, whose answer admitted that he had used an exhaust regulated so as to reduce the pressure within the case to its normal point, though he denied the use of any blast, was still shown to have used a new and material part of the process patented, and was therefore an infringer. His appeal would therefore be dismissed with costs, to be taxed in the same way as stated in the decree—*i.e.*, as between solicitor and clients.

REVIEWS OF NEW BOOKS.

A Treatise on the Metallurgy of Iron, with Outlines of the History of the Manufacture, Methods of Assay, and Processes of Manufacture of Iron and Steel. By H. Bauerman, F.G.S., Assoc. Royal School of Mines. 1 vol. 8vo. cloth, with illustrations. London: Virtue & Co. 1868.

We hesitate not to affirm that, though this is a small volume, under 400 well-printed octavo pages, with many good woodcuts, it is the best work on the general metallurgy of iron in the English language. Its limits and intentionally rudimentary character, of course, prevent its dealing with or discussing minute points of theory or practice, for which the large works of Percy or Truran, &c., must be consulted; but for a sharp and clear picture of the entire scope of iron and steel history and manufacture it stands alone in English, and its production is highly creditable to its young author, and through him reflects credit on the School of Mines in Jermyn Street, where he in part received his technical education. The first two chapters are devoted to an admirable outline of the early history of iron and its production, and a sketch of the chemistry of the metal itself. The next two treat of the nature and distribution of the ores of iron, and of the most recent and important methods for the assay and analysis of such ores. Then follow four upon the preparation (in modern practice) of the ores, their roasting or calcination, the fluxes employed in iron making, and the blast and management of that. We then come to smelting proper, treated of in two able chapters. The nature, varieties, and composition of pig iron are then treated of; and then we proceed to wrought iron, in describing the early method (still practised in some regions) of obtaining wrought iron direct from the ore. After that the processes of refining, puddling, &c., for making wrought iron on the great scale of modern times are described, and the descriptions accompanied by admirable theoretic commentary. Forge and mill machinery, re-heating, welding, &c., are treated of as fully as is necessary for an elementary work. An account of the Bessemer and other steel processes is then given, and in the last chapter the latest methods of assay and analysis of cast iron, wrought iron, and steel. No better book can be put into the hand of the pupil of mechanical or civil engineering in any of its specialities; nor is there any English work in which those not directly concerned with the practical uses of iron, but who desire to know something accurately about our mighty national industry, can find a clearer and more complete and readable account thereof.

Engineering Facts and Figures for 1867, &c. 1 vol. 8vo. London and Edinburgh: Fullarton. 1868.

This annual volume (the preceding ones of the series we have heretofore noticed) is quite as good as its predecessors, in a few points rather better; as, for example, in the record of facts as to petroleum and liquid fuel here given and very usefully collected. It is useless to occupy space by entering into anything like a synopsis of the contents of a volume like this, which itself only pretends to be a mirror for the facts and new views obtained during the year past.

Chemistry, Inorganic and Organic, with Experiments and a Comparison of Equivalent and Molecular Formulæ. By Charles Loudon Bloxam, Prof. Chem. King's Coll., &c. 1 thick vol. 8vo., with numerous woodcuts. London: Churchill. 1867.

It demands rare ability in any man to condense into a single thick volume anything like a complete statement of the facts and theory of the whole of chemistry as it exists now-a-days. It is here, however, very ably done; nothing that ought to be noticed is omitted, nothing important slurred over; and between the lucidity of style, the rapid detail of experimental illustrations, made clear by the capital woodcuts, and the frequent reference of abstract facts to concrete results and examples in manufactures and arts, we know of no work of the same magnitude in English more likely to fascinate the attention and rapidly instruct the student. The chief *special* direction given by the author, who is professor at Woolwich, to any part of his work is in those portions of it which regard the materials employed in warfare. To the analytical chemist or chemical manufacturer the work may form a good reference index, before applying to larger systematic works. The author acknowledges his obligations in the part bearing on organic chemistry to the corresponding volume of Dr. Miller's splendid three volume system, of which we can say nothing higher in praise than to state the simple fact, that consulting it frequently we have never yet done so in vain, or without finding, however tersely, some information as to what we sought.

Iron Shipbuilding, with Practical Illustrations. By John Grantham, M.I.C.E., &c. Fifth Edition, with Supplement and Index. 8vo. With folio Atlas of Plates. London: Virtue & Co. 1868.

This work not only maintains its old, but has the right now to command increased and new reputation in virtue of the additions made to its matter. It is a thoroughly practical work, and every question of the many in relation to iron shipping which admit of diversity of opinion, or have various and conflicting personal interests attached to them, is treated with sober and impartial wisdom and good sense. This is remarkably so in the cases in which Mr. Grantham might have been supposed to have a marked and natural personal bias, as for certain inventions of his own, which are treated quite as impartially of, as those belonging to others.

Mr. Grantham's method for coppering the bottoms of iron ships by the intervention of a thickness of wood attached to the iron skin, in *the only* way that we are acquainted with which can be deemed workmanlike and safe, has been either strangely neglected, or kept back by prejudice; and we should gladly see it tried upon a large scale and with perfect impartiality, as we understand it is likely now to be soon, by the Admiralty. This work of Mr. Grantham's is as good a volume for the instruction of the pupil or student of iron naval architecture as can be found in any language, and would advantageously precede the study of such ponderous works as those of Rankine and Scott Russell.

Upon one of the most interesting, because most important matters which relate to iron ships—their *fouling*, and the means to prevent that—Mr. Grantham says but little beyond reaffirming the fact, that no effectual method of preventing fouling by any paint or coating has yet been discovered. Indeed there were but little use in discussing the relative merits and calling up the fierce trade rivalries of some fifty anti-fouling nostrums, when the fact is that *not one of them* answers its alleged purpose. Yet we cannot admit that the subject is exhausted, although it is so in the directions in which the venders of anti-fouling compositions have hitherto gone. We believe it is still within the possibilities in nature for the chemist or iron metallurgist to devise means by which the hull of an iron ship may cease to be acted on by air and water; and that done, the fouling problem solves itself, for corrosion *must* precede fouling, as neither animals nor plants attach themselves to plates of clean iron, or clean varnished surfaces thereof.

Irrigation in Spain—Information collected during a Residence of Several Years in that Country. By J. P. Roberts, C.E. 8vo. pamphlet. London: Spon. 1867.

An excellent pamphlet, full of information, collected and digested by an obviously competent man; one that the tribe of irrigation engineers, lately sent out to India, would do well to take in their pockets. The information it contains is largely of an original character, and not to be found in stock books of engineering, and Spanish writers on the irrigation of Spain are referred to; but the author does not appear to be himself acquainted with much of the very important French literature of his subject which is in existence, notably the magnificent works of M. Dupuis, "Sur le conduit des Eaux," and "Irrigations du midi de l'Espagne" of M. Aymard, with the report of M. Lebasteur. The last have been published by authority of Marshal Duc de Malakoff, governor of Algeria.

Few more instructive lessons as to methods of irrigation, ancient and modern, are to be found than were afforded by the fine collection of photographs shown at the Exhibition of last year at Paris, exhibiting the ancient methods, and contrasting them with the modern and recent ones, in which the venerable old scripture prediction, "Thou shalt water the land with thy foot," has in these latter days been superseded by the steam pump.

The Ocean World; being a Descriptive History of the Sea and its Living Inhabitants. By Louis Figuier. 1 vol. large 8vo, with 427 Engravings. London: Chapman & Hall. 1868.

Mons. Figuier is the prince and chief of all *vulgarizateurs*, and an English version of this beautiful and interesting volume, and so admirably illustrated, is a real boon to the great class of English sea-side holiday folk, and a welcome addition to the library of the student of natural history, extending over a very wide portion of its whole domain. The work consists of nineteen chapters, the two first of which are devoted to the physical history, &c., of the ocean itself; its constitution, movements, currents and their causes, winds, &c., &c. The third chapter treats of the nature and distribution of life in the ocean; and then the remaining chapters pass before us in order, from the infusoria and polypes up to the vertebrate fishes, all the classes of animals which the ocean supports. Why oceanic and littoral birds and insects should have been omitted, however, we do not quite see, in a work which proposes to describe "the things innumerable" which look to old ocean as their home.

A Treatise on the Petroleum Zones of Italy. By E. St. John Fairman, F.G.S., &c. Spon, London. 1868. 8vo, with maps.

Although this pamphlet in boards is, as it honestly professes to be, a harbinger to the establishment of a joint stock company for the purpose of working the petroleum springs of the Modenese Appenines—that is to say, of those mountains along the whole stretch between Piacenza and Bologna, where they mainly consist of *macigno* formation—it yet is one containing a great deal of information as to the economic geology of that region, and a good deal not commonly known. We happen ourselves to possess some special knowledge as to Appenine geology, from north to south of the Italian peninsula, and can confirm the *existence* of petroleum in many localities. As to its ever being found, anywhere in Italy, in anything approaching American abundance, we entertain a distinct negative opinion. Whether that which is found may be well worth *exploitation* (we have no word so good in English) or not, will, in our judgment, mainly depend on the chemical character of the petroleum itself. If that be such, that it can yield *benzine*, and so *aniline dyes*, then is it eminently promising; if not, far less so. As the petroleum comes from lignites, we think the supposition is highly probable and the prospect favourable.

Sanitary Siftings, or Results of Sewage Systems Compared. By a Naval Officer. Pamphlet. Spon, London. 1868.

Why, above all other conceivable things, a naval officer should take up that peculiarly land-lubber's subject, sewage; that one whose home is on the deep, and whose cesspool is the entire ocean, should be the one to tell us how we inlanders and city-cabined folk are to best get rid of our refuse—is one of those things that "no fellah can understand," unless on the assumption that there are a great many "naval officers" just now out of a job in "blue water," and so have taken to muddling in that which is neither blue nor clean.

Our present naval officer writes clear and terse English enough, and, his calling notwithstanding, knows a good deal about "sewage" and other foul "*recrementa;*" of all, or nearly all, the plans for disposing of which he has given here a very fair *resumé*, and, with more or less judiciousness, pointed out their respective weak points. But when we come near the end, and long to get at the pith and marrow of all that has been gone through, lo! what an anticlimax: we find the pamphlet to be but in deed and fact a puff, for the system of earth closets of that most appropriately named "clerk in orders" and inventor of the same, the Rev. Henry Moule.

A Treatise on the Mechanical Means by which Vessels are Propelled by Steam Power. By William Hale, C.E. 8vo. Longmans. 1868. With diagrams.

The drift of this pamphlet, for it is no more, though printed in all the luxury of large type, thick paper, and engraved plates, seems to be to affirm for the author that he really was the inventor in England of twin screws; that in patenting that invention he was compelled, by American priority, to limit himself to twin screws working in longitudinally placed cylinders within the ship, and so becoming expellors of a stream of water, *a retro;* and to declare his adherence still, to the opinion he formed then, of the value of water-jet propulsion; the conclusion of the whole matter being the enunciation of a peculiar form of water-ejecting propellor, to which great virtues are assigned, but the description of which in detail, unaided, as by a most singular omission it is, of any diagrams, we confess ourselves unable to follow. We certainly were not predisposed to give very much thought to it, after reading the cloudy and irrelevant stuff about whether an oar be a lever of the first or second order, which occupies pages 1 to 6, and in his mechanical views as to which Mr. Hale is most decidedly wrong.

The Construction of Locks. By Charles Tomlinson, Esq., King's Coll., Lon. A new edition, with appendices by J. Beverley Fenby on his patent locks, and one on iron safes by R. Mallet. Virtue & Co. 1868.

This is a volume of the reissue of Weale's rudimentary series. The greater portion of the volume consists of Mr. Tomlinson's historical treatise on locks, the ability of which is already well known publicly.

The appendix of Mr. Fenby, which constitutes the thirteenth chapter, brings the subject of locks in fact up to the present time, and describes one of the most original and ingenious lock combinations ever made, viz., that of his patent adytic lock.

The volume concludes with a note by Mr. Mallet, in which he has placed, free of a great deal of the trade *charlatanerie* of the safe-makers, the principles upon which the actual safety of safes or strong boxes really depends, and shown in a common sense way how every one that wishes it, and will resolve to pay for it, can insure having such a depositary.

Armour Plating, with a Description of a New System of Iron or Steel Armour. By Gustav Julius Gunther. 8vo pamphlet. Illustrated. London: Wilson. 1868.

The very title of this pamphlet is almost sufficient to show to the initiated that the author probably does not know much about the subject on which he professes to throw new light, as steel has been superabundantly proved a much worse material than soft iron for armour plating. We have only to look at the large colour-printed lithograph which is part of the production, to see at once that Mr. Günther treats of a subject on which he lacks even the most rudimentary knowledge, both theoretical and derived from the extensive experimental information now possessed by those really up to the existing position of the question. There is, however, nothing novel nor anything amazing in the fact, that people who really know *nothing at all* about a subject, rush forth full of the idea that they are able to teach those who have laboriously studied it.

Notes on the History, Methods, and Technological Importance of Descriptive Geometry, compiled with Reference to Technical Education in France, Germany, and Great Britain. By Alexander W. Cunningham. 8vo pamphlet. Edinburgh. 1868.

This is a very clever, learned, and we may say able sketch of the rise, progress, history, and an encomium on the value and uses of descriptive geometry, which, according to the author, might be defined as the method of applying graphic construction to figures of three dimensions.

The author has shown how early this attracted some attention in England, and yet how much greater has been the attention given to it in modern times on the Continent than amongst ourselves. He has also, we think, fully shown its value as a branch of information to those engaged in technical pursuits. But with all the display, and there is a good deal of that, of learning and historico-scientific scholarship, we fail to discern what tangible or practical proposition the author has to make in relation to improved technical education in Great Britain, or how or in what way, and to what extent, he would aim at connecting his favourite descriptive geometry with better education of any sort.

SHORT NOTICES.

The tenth part of "The Austrian Official Reports on the Exhibition of 1867" ("Officieller Ausstellungs-bericht," &c.) has appeared, containing reports on the classes 41, 42, and 49. This part refers to forest produce, direct (*i.e.*, timber, &c.) and indirect (viz., turpentines, gums, dye stuffs, &c.), by Herren. Wessely, Wiesner, and von Maurer, the last of whom treats of hunting and fishing tackle. There are two lithographic plates of the tools employed in various regions for the extraction of turpentine, &c. The account of the industry which gives us our bungs and bottle corks is very interesting, and the whole part is executed with the same excellence as those which preceded it.

The "Hannoverisches Wochenblatt für Handel und Gewerbe" continues to appear weekly, and under its old national title, as before Hanover was absorbed by Prussia. It seems a little odd that even this mild assertion of separate existence should be tolerated now. One, to English eyes, odd characteristic of this little periodical, is its putting its obituary notices of deceased mechanicians, &c., in the very forefront of each number, within a large black-bordered rectangle. The articles are generally brief and of average merit There are a few, such as that of Fischer on the guiding or characteristic forms of saw teeth, in the part of June last, of greater length and originality.

The April, 1868, part of the "Zeitschrift des Vereines Deutscher Ingenieure," &c., contains amongst much other interesting matter, a valuable article on the proper form for drills for boring wrought iron, by von Heim, an engineer of Wasseralfingen. The German engineers have not been neglectful of Mallet's buckled plates, now that these have been shown them at Paris; there is a long account of these in the part.

"Elemente der Petrographie," &c., von Dr. Adolph Kenngott, of Zurich, 1 vol. small 8vo, is a useful and condensed account, upon a perfectly scientific basis of constitution, derived from constituent simple minerals, of all the great stony or rock formations. It is a work of equal value to the scientific geologist and miner, and ought to be so to the architect and engineer, if these, in Great Britain at least, chose their building materials not by maxim and precedent, or at haphazard, but upon principles which, justly applied, do not lead to the deceptive results we see in such cases as the Houses of Parliament.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

SEWAGE PRACTICALLY DEALT WITH.

(To the Editor of the Practical Mechanic's Journal.)

Sir,—It has been suggested before now that peat ash should be mixed with solid refuse, and that the dry method renders such a composite manure quite inoffensive, and no doubt it does; but to ship peat from Ireland would probably not suit for the metropolis, as the freight, &c., in the first place, would cost a deal of money. But in convenient localities manufacturing dry manure could both be cheaply and effectually carried out, and I cannot see anything to hinder the "Emerald Isle" becoming a manufacturing depot, and exporter of "dry British guano." I am not sufficiently acquainted with the soil to point out the proper spot for carrying on the manufacture, but I have no doubt there are many places very conveniently situated not far from large towns, and at no great distance from peat bogs; and whether the sewage is pumped up, or where it simply flows away by gravitation, from the town to the manufacturing depot, is simply a matter of engineering, and in the method I am about to describe, the process of manufacture could be carried on quite inoffensively. Taking the population of a town at 200,000, we would have in round numbers 39 tons of solid filth daily to be utilized (or 1338 tons daily for the metropolis; does not this silt up the Thames, delivered at one place?); to collect this inoffensively a building is required, and I should say a circular one is to be preferred, the probable diameter being 100 feet, having a central column for carrying stages, and as a column to carry the roof, this being necessary to retain the offensive gases where such a building is situated near a town. All round, the building would be supported with suitable open arches, and the piers having strong abutments on the outside, in this reservoir would be poured all the sewage, and the filtering and retaining media placed outside of the building. Firstly, a bed of rough ashes should be filled in, covering a considerable area all round, and of sufficient depth to leave several feet above the arches in the reservoir. I should think, were the ashes covering a larger area, no other filtering media would be required, but on the outside of all a wreath of sand would effectually purify the sewage water. Thus, the sewage poured into the reservoir would settle at the bottom, and the water would percolate through the filtering bed until the reservoir would become full. The sewage would then be turned into another reservoir (for in dealing with sewage we must not do things by halves); then the process of manufacturing would commence; prior to that peat ash and other finer materials should be mixed with the sewage, so as to suck up and form the deposits into layers, or render it more fit for the drying process. Adjoining the reservoir should be constructed a furnace with a fire-brick oven, having a high chimney; the furnace would be fired with peat, the hot air from the oven passing into the building, which would thus be heated to a suitable temperature; and the noxious gases evolved should pass through the furnace to be purified, and then up the chimney, the peat ash or charcoal being utilized in the adjoining reservoirs, and so on. Thus, I consider we could quickly and cheaply manufacture dry manure in a wholesale manner. As regards who is to undertake the process of manufacture upon the various suggestions I have laid before you, suited for certain localities, of course the Board of Works for each town should. In London the ashes are turned into bricks; how much more profitable to deodorize the sewage therewith than by drying the compost as proposed! It could be conveyed to the farmer in an inoffensive manner, or when land has to be reclaimed spread it over the surface, having a sandy bottom to work on, the ashes being left in their rough state; but, of course, for general purposes the dry manure should be ground small, or the ash, &c., sifted from the cinders before applying it to the sewage. The value of dry British guano has been estimated at an absurdly high figure, and by others at little or no value, when in its natural state, or thick fluid manure; and as such I consider the farmer will have nothing whatever to do with it, owing to the expense of the necessary plant, &c. Steam ploughing is of far more importance than scheming how to apply liquid manure for grain crops, as a strong concentrated and portable manure can be made, if we only take the necessary steps to do so, provide it to the farmer in a cheap and inoffensive manner, and let each town vie with each other in manufacturing it cheaply. Thanking you for the space you have from time to time granted,

Yours truly,

JOHN G. WINTON.

London, 26*th January*, 1868.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—Would you let me know through the columns of the *Practical Mechanic's Journal* the best method of boring artesian wells successfully, and the probable cost of apparatus necessary to that end? Would "Suggett's" pump, described in your journal for March, 1868, answer here, or the recent experiments by driving tried in London and recommended for the use of the Abyssinian expedition? which would you recommend as best? I send the geographical formation of the coast land as found by sinking an artesian well at Mahaica.

Geographical formation of the coast lands as discovered by the borings on the Woodlands, Mahaica:—1 to 5 feet surface soil; 6, layers of caddy or fine sand; 7 to 9, blue clay; 9 to 39, soft mud mixed with caddy, in which the auger went down by its own weight; 39 to 53, rotten wood and pegass, or decayed vegetable matter; 53 to 55, bluish gray clay, stiff: 55 to 57, clay a little red and gray; 57 to 70, reddish clay; 70 to 82 feet 10 inches, yellowish gray clay, with a little sand and ochre, very stiff; 82 feet 10 inches to 86 feet 8 inches, bluish gray clay, streaked; 86 feet 8 inches to 92 feet, bluish gray clay, streaked with yellow; the bed of sand from which water was obtained was reached at a depth of 118 feet, and the same stratum was found at 125 feet.—I am, Sir, your obedient servant,

A SUBSCRIBER TO YOUR JOURNAL.

Berbice, 22*nd June*, 1868.

[The inquiry of our correspondent is two-fold. 1st. Whether the "American tube well" system be applicable to his case. Assuming that at Berbice there is from 120 to 130 feet or more of soft, and in part running strata, to be gone through before the water-bearing bed is reached, we should say that the tube well would prove an insufficient method, even if carried to that depth without difficulty or accident, and that it very probably would prove impossible to get it down to the necessary depth at all. Greater yield of water also is required in such a climate as Berbice than small bore holes commonly yield.

2nd. As to the general inquiry as to the best method of boring artesian wells, &c., the answer might be to write a treatise. For such strata as the writer describes, or for others, we should advise some one interested, and with sufficient capital, in the colony, to get out a complete set of Mather (of Bolton and Manchester) artesian well sinking apparatus, worked by steam power, with a skilled workman to employ it; and to get out lining tubes for the wells, and to attempt none under 24 inches clear diameter. The Kind & Chaudron Co. can also supply apparatus from Belgium or Paris, but for Berbice we should prefer the English methods.—Ed.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

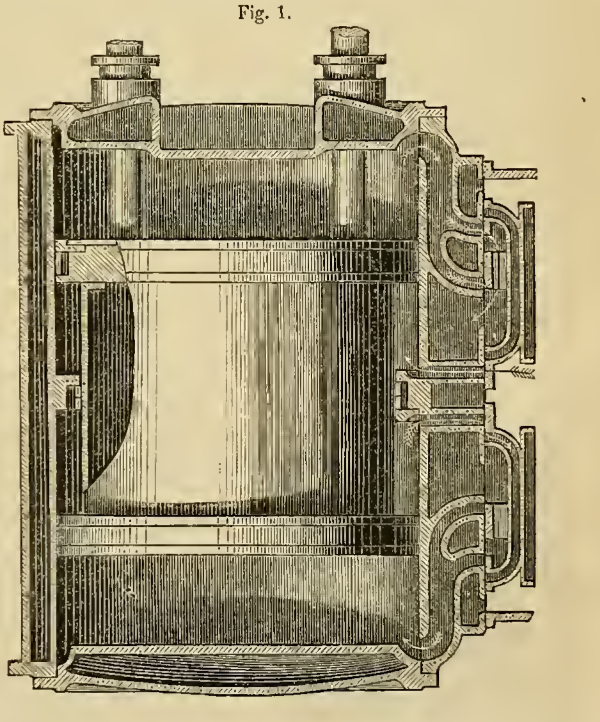
INSTITUTION OF NAVAL ARCHITECTS.

DESCRIPTION OF NEW DOUBLE EXPANSIVE ENGINES FOR H.M. SHIP *SPARTAN*. By Edward Ellis Allen, Esq.

I have been invited to contribute a short paper for this year's meeting of the Institution of Naval Architects, descriptive of the engines now in course of construction by Messrs. J. & G. Rennie for H.M. ship *Spartan*. I regret that I cannot enter very fully into the details of their construction, the manufacturers being naturally anxious to complete and subject them to a thorough trial before submitting their details to professional men; the engines in question being the first of their kind of any considerable power, as also the first intended for marine purposes. As, however, a large number of engines of from 6 to 20 horse-power have been constructed upon precisely the same principle for pumping, sawing, ploughing, and other purposes, some of which have been constantly at work for upwards of four years, giving great satisfaction, I have no fear as to the results of the engines of the *Spartan*. Assuming, however, that some of the details adopted in these engines are capable of improvement, it is most improbable that any difficulty can arise in making it, the same general plan of construction being capable of being carried out in practice in various ways.

The engines of the *Spartan* are 350 nominal horse-power, and are intended, when exerting their full force, to give out 2100 horse-power by indicator, *i.e.*, six times the nominal power, when the expansion is carried to about seven times, the pressure of steam in the boilers being 55 lbs. per square inch above the atmosphere, or about 70 lbs. total pressure.* The cylinders are 64 inches in diameter, and the stroke 2 feet 9 inches. They are formed as shown in fig. 1, their length being rather more than twice the length of the stroke. Each cylinder is divided into two portions by means of a division cast with it, and furnished with metallic packing similar to that of a piston, but acting inwards instead of outwards. Through this division a trunk works, having a piston at each end packed in the ordinary way. The trunk is made to occupy about three-fourths of the capacity of the cylinder, being in this case 56 inches in diameter, thus allowing an annular space of 4 inches.

Fig. 1.



The steam is admitted from the boiler alternately into the annular spaces formed on each side of the division in the cylinder, being cut off by lap on the valve at about five-eighths of the stroke, or by means of the link motion at any less part of the stroke, and afterwards passes to the respective ends of the cylinder, where it is fully expanded; that is, in the ratio of the areas of the whole cylinder to the area of the annular space. From the ends of the cylinder the steam escapes in the ordinary way to the condenser. The cylinders are steam-jacketed as well as both the covers, and, if necessary, steam may be readily admitted to the trunk; but the large surface of the cylinder being available for keeping up the temperature of the steam during expansion (especially effective as regards the steam contained in the annular space), will probably never render it necessary to admit steam into the trunk for heating purposes.

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* It is usual now for the Government to contract that their engines should give out six times the nominal power when the steam is expanded three times.

The boilers of the *Spartan* are six in number, each $9\frac{1}{2}$ feet in diameter, with circular furnaces 3 feet in diameter. Each boiler contains a number of tubes over the furnaces, and a superheater is formed in the uptake.

One surface condenser serves for both engines, and is of the ordinary kind, the steam being made to circulate on the outside of the tubes, cold water supplied by centrifugal pumps being driven through them.

The valves of the cylinders are shown in fig. 1, each valve having double ports for exhausting. The pressure of steam on back of valves is removed in the ordinary way. Both valves are worked by one rod, and are driven by double eccentrics with link motion in the ordinary way.

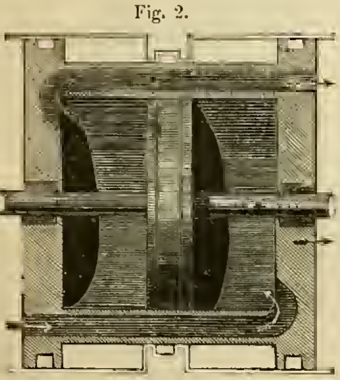
The engines are placed horizontally, and are of the ordinary double piston-rod construction, with return connecting rods, their peculiarity alone consisting in the construction of the cylinders and valves. When working with the link motion in full gear the steam will be expanded about seven times, and the expansion can readily be increased to ten or twelve times when required.

The advantages of the arrangement are chiefly its capability of fully expanding steam of considerable pressure; uniformity of action—the high and low pressure steam acting simultaneously; the diminution of the strain thrown on the piston rods, connecting rods, and guides, in consequence of the steam from the boiler never acting directly upon the large area of the piston, its expansion in the annular space reducing the pressure to nearly half that at which it is first admitted into this space before it passes to the cylinder ends. In the case of the engines already constructed, the trunk is found to be amply supported by the end pistons (each of which may be narrower than an ordinary piston), as well as by the central packing, the cylinders being very equally worn. The steam passages are also very short, and consequently there is little loss in charging them.

In order to avoid any accumulation of pressure by successive changes of the passage through the valves, they are so constructed as to be charged with high steam at each stroke, the edge of the valve passing over its seat. The same object could be accomplished in another way, viz., by exhausting the passages in the valve at each stroke.

It may be well to glance at one or two of the objections which have been made to the form of engine here described; and, first, as to the difficulty of keeping the division and the cylinder steam-tight. In answer to this, I may state, first, that no such difficulty has occurred in any of the engines already constructed; but if a leakage should occur, the steam escaping at once finds its way to the end of the cylinder, increasing the pressure of the expanding steam, the equilibrium ports always being open when the steam is entering the annular space on the opposite side. The loss, therefore, of leakage in this way is really very small, the steam not being lost as if leaking past a piston. Moreover, there is always steam on both sides of the division and the cylinder, there never being a vacuum on one side and steam on the other. The large surface of the cylinder has been thought by some to be objectionable; but, so far as experience goes, it is really one of good points in the arrangement, affording, as it apparently does, ample heating surface for the expanding steam. Admitting steam to the trunk for the purpose of adding to this heating surface has been objected to, on the ground that it was impossible to make the trunk hotter than the steam. This of course is evident, but the question is whether the steam, during expansion, is capable of taking up more heat than the jacket can transmit; if so, good may arise from admitting steam to the trunk.

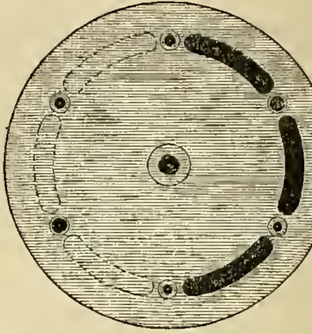
Fig. 2.



I may here perhaps shortly describe another use to which the trunk may be put, *i.e.*, in engines worked by steam of a still higher pressure than that to be used in the case of the *Spartan's* engines. This is shown in fig. 2. The trunk is made cellular, and is bored out so as to receive a piston, which is kept stationary by a rod attached to one or both cylinder covers. The passages for the steam are found all round the trunk, between the outer and inner skins, one-half of them opening out at opposite ends as shown, so rendering the capacity of the trunk available as space for expansion, and adding from 50 to 70 per cent. to it, according to the proportion of the trunk to the whole cylinder. By this arrangement it would be easy to provide for expansion to the extent of twenty times, using steam of 100 lbs., 120 lbs., or even 150 lbs. pressure The speed of the *Spartan's* engines will be about 100 revolutions per minute, equal to a piston speed of 550 feet.

With regard to the question of economy of fuel from the use of steam of 50 lbs. to 60 lbs. pressure, well expanded and afterwards condensed, it may be difficult to determine; but I have every hope that it will be below 2 lbs. per indicated horse-power, and if the pressure be increased to 120 lbs., as I believe it shortly will, I think we may hope to see $1\frac{1}{2}$ lb. good coal doing the work of an indicated horse-power. In the high-pressure engines I am now working on the principle described, and of which diagrams are exhibited, I have reduced the consumption of fuel to less than one-half, and in some cases to one-third, that of ordinary engines, cutting off at three-fourths of the stroke, and consuming only one-third of the water, viz., $2\frac{1}{4}$ gallons per dynametrical horse-power. In these engines, which are mostly portable engines, I use mostly 75 lbs. steam, expanding it six or seven times, reducing the exhaust steam nearly to zero, and thus avoiding all noise or escape of vapour in a visible form, except in cold weather, or when the air is charged with moisture. One marked advantage of the arrangement for portable engines is the fixed nature of the expansion, such engines very rarely being fitted with expansion link motion, or any other means of working the steam expansively; the link motion, even if fitted, affording no check to the driver working it in full gear, and consequently the steam non-expansively.

Fig. 3.

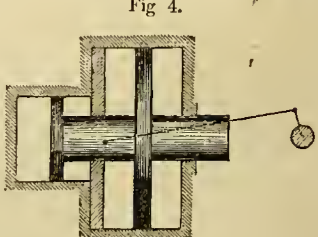


I need scarcely remind you that any arrangement calculated to economize steam renders the boilers either proportionately smaller, lighter, and cheaper, or more effective as economical steam generators; the saving from economy of steam being twofold—first, directly in reducing the quantity of water to be evaporated for a given power; and secondly, in rendering the boilers more economical on account of the relative increase of heating surface.

In suggesting points upon which any discussion may most profitably turn, I would direct attention to the vast importance of economizing fuel in ships of war, more especially those that are armour plated. In many of these it is well known that three or four days' coal is all that can now be carried, *i.e.*, when full steaming. Now, this quantity (whatever the actual amount required may be) must, I think, sooner or later serve for twelve or fifteen days, so as to carry the vessels some 5000 miles without recoaling. How is this to be accomplished? It seems to me there is only one way, viz., by employing steam of considerable pressure, liberally expanding it in some form of double expansive engine, condensing, of course, by surface, and a moderate amount of superheating, or, as I prefer describing it, using dry steam. In discussing the merits of an engine, therefore, it seems to me one of the most important questions is, whether it is equal to this advanced service to which it must probably soon be put. All our ironclads are terribly defective, as it seems to me, in what we may call the "wind and pace" of vessels. They neither go far enough nor fast enough, and ere long these points must be attended to, whatever difficulties may be met with in accomplishing the end in view.

With regard to the speed of ships of war, it has well been said that the speed of a fleet is that of the slowest vessel in it. Now this should be 14 knots, if not 15 knots, an hour, whereas that of our ships is from 9 knots to 14 knots at their best. One requirement seems to have been entirely overlooked, viz., that if any number of vessels are required to move at an uniform steam, they must have what I would call surplus power. This has never been provided for, nor can it ever be, except by the use of high-pressure steam, with ample provision for expansion and adequate cylinder capacity. The variation in speed of vessels, due to the state of the surface below water, indifferent quality of coal, and other causes, cannot be put at less than 2 knots, so that to maintain 15 knots at sea, and at all times (which has been insisted upon by many competent authorities as necessary), provision must be made for 17 knots or 18 knots an hour. This surplus power appears to me as necessary for the ships of a fleet as for the locomotives of a railway; and further, that some such concentration of power is essential in order to meet the requirements of ships in the Royal Navy.

Fig 4.



I have during the last fourteen years paid considerable attention to the economy of fuel in steam-ships, and have devised five classes of double expansive engines with this end in view, diagrams of which are exhibited, the engines of the *Spartan* being, I think, the best; but, curiously enough, nothing more than a kind of stereoscopic blending of the "combined trunk" engines of 1855. In the *Spartan's* engines the two cylinders of this first arrangement are joined together, the one trunk serving for both pistons. This apparently very simple change did not, however, occur to me until seven years after my first production. During the last few years I have had the satisfaction of seeing three of my plans practically adopted in steam vessels; arrangements which are perfectly new to me, and honestly devised, after a careful study of the future requirements of marine engines, being now looked upon as very obvious modifications. Thirteen or fourteen years ago, however, the expansion of steam in marine engines was almost without a single advocate, the supposed necessity of making them as light as possible being considered paramount to every other consideration. In the beginning of 1855 I ventured to suggest that the government should invite tenders for marine engines, in which "economy of fuel" was the object sought, in the same manner as they had done some time previously when "economy in space and weight" were the objects proposed. Some years before this suggestion was acted upon in ordering the three vessels—*Octavia*, *Constance*, and *Arethusa*; and these had given rise to the present trial of the engines intended for the *Spartan*, as well as of another form of double expansive engine in course of construction by Messrs. Maudslay. The end-to-end cylinder engine, with trunk connection, designed by me in 1855, has been carried out in the engines of the *Poonah* for the Peninsular and Oriental Company, and for the engines of her Majesty's ships *Pallas*, *Crocodile*, and *Serapis*, while the same arrangement, with double connecting rods, has been in use in the Peninsular and Oriental Company's ships *Delhi* and *Tanjore*. The annular cylinder arrangement has been worked out by a manufacturer for the Swedish government, and I believe with good results. The vast importance of modifying the ordinary construction of engines in which steam of even 50 lbs. pressure is employed, will be seen by considering the strain to which the engines of the *Spartan* would be subjected, if the steam were admitted at once at full pressure upon the whole surface of the piston being not less than 70 tons, while for the large engines of the *Northumberland* class it would not be much short of 300 tons alternately on both sides of each piston, perhaps 120 times a minute. As the pressure of steam increases, so does the necessity become greater for employing double expansive engines. The future progress of marine engineering in the Royal Navy is a question of the greatest possible interest, and I shall be well repaid should the proposed discussion throw any light upon the subject, which it can scarcely fail to do.

In the discussion which followed, the chairman remarked it was a very large and important question, and well worthy the consideration of every gentleman who took an interest in marine engineering, and as applied to boiler makers and engine makers.—Mr. Grantham said he thought it was a pity that the paper should go off without some discussion. He would offer two or three remarks which had suggested themselves during the reading of the paper. He thought that gentlemen were apt to lay too much stress on the importance of economy of fuel in the navy. In his opinion it was far more important to the mercantile marine, where there were ten or twenty ships for one in the navy. However important it might be to save fuel in the navy, it was only for the promotion of our self-glorification, and, in some remote measure, to the glory of our country; but in the other it was of importance to the world at large and the whole commercial marine of the country. A large number of engineers had attempted annular engines, and he had seen one that was used in the gunboats of Sweden, in the Exhibition of 1862. He did not wish to disparage the plan now before the meeting, and was sure that everything which would conduce to the employment of high-pressure steam used expansively in our ships was by far the most important direction on the question of economy of fuel. It would be a very narrow view to think that we had arrived at the highest point of perfection; and, although you hear of such economical engines, the great majority of engines were worked at an extravagant expense of fuel. He thought there was some little difficulty as to Mr. Allen's plan, but probably it only arose in his own mind and could be easily explained.—Mr. Allen said, with reference to the engine in the Exhibition, it was his own plan worked out for the Swedish government. The arrangement was that the high-pressure cylinder was in the inside of the low-pressure one, which made a neat arrangement in many respects. The high-pressure steam passages were very long. It worked a good engine, but took up rather more room than some of the other kinds.—Mr. Harland thought it would be desirable for engineers to turn their attention to the boilers best suited to produce steam. The fault had not been the inability of the engineers to produce the steam engines, but the difficulty was that of producing the steam boiler. He would suggest that engineers should consider thoroughly the production of a first-class boiler which would stand wear and tear, and be easily repaired.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

A SEARCH FOR SOLID BODIES IN THE ATMOSPHERE.

By R. Angus Smith, Ph.D., F.R.S., &c.

I have so frequently for many years attempted to find, and have found, organic substances which have passed from the air into liquids in which they were collected, that perhaps the society will scarcely attend to another attempt, although it indicates, I think, some progress. It was in the year 1847 that I first collected what I believe was matter from the respiration and perspiration, and found that as it was kept it grew into distinct confirmed forms.

Whilst examining some matters relating to the cattle plague I found one or two remarkable points. I had before that time used aspirators to pass the air through liquids, except in the oxidation experiments. At that time I used simply a bottle which contained a little water. The bottle was filled with the air of the place, and the water shaken in it. The difference of air was remarkable. A very few repetitions would cause the liquid to be muddy, and the particles found in many places were distinctly organic.

Lately I tried the same plan on a larger scale. A bottle of the capacity of $\frac{499}{1000}$ c.c. was filled with air and shaken with water. The bottle was again filled and shaken with the same water, and this was repeated 500 times, nearly equal to 2½ million cbc., or 2495 litres. As this could not be done in a short time, there was considerable variety of weather, but chiefly dry, with a westerly wind. The operation was conducted behind my laboratory, in the neighbourhood of places not very clear, it is true, but from which the wind was blowing to all parts of the town. I did not observe any dust blowing, but if there were dust, it was such as we may be called on to breathe. The liquid was clouded, and the unaided eye could perceive that particles, very light, were floating. When examined by a microscope the scene was varied in a very high degree—there was evidently organic life. I thought it better to carry the whole to Mr. Dancer, and to leave him to do the rest, as my knowledge of microscopic forms is so trifling compared to his. It may, however, interest the society to hear a few of these previous attempts, the latest made till recently. I shall therefore read from a report to be found in the appendix to that on the cattle plague.

Mr. Crookes also brought me some cotton through which air from an infected place had passed. It was examined at the same time. Taking cotton in the mass nothing decided was seen; but when it was washed some of the separate films were coated over with small nearly round bodies, presenting no structure, or at least only feeble traces of it, and perhaps to be called cells. I had not sent gun-cotton, as I intended, to Mr. Crookes, fearing the rules of the post; otherwise there would have been more certainty that the bodies spoken of did not exist previously on the cotton. However, Mr. Dancer, who has examined cotton with the microscope oftener than most persons, even of those experienced in the subject, had never observed a similar appearance. The liquid had also a number of similar bodies floating in it.

It was then that Mr. Crookes sent a liquid which he had condensed from the air of an infected cowshed at a space a little above the head of a diseased cow. It was also examined, and it presented similar indications of very numerous small bodies. Not being a professed microscopist, I shall not attempt a description, but add that they clearly belonged to the organic world, and were not in all cases mere debris. We found also one body a good deal larger than the rest; it resembled a paramecium, although clearly not one.

We found no motion whatever, and only this latter substance could be adduced as an absolute proof of anything organized being present. Next day I examined the same liquid; and, whether from the fact of time being given for development or from other causes, there was a very abundant motion. There were at least six specimens in the field at a time, of a body resembling the englena, although smaller than I have seen it. When these minute bodies occur it is clear that more may exist, and germs in this early stage are too indefinite to be described. The existence of vital sparks in the organic substances in the air alluded to is all I wish to assert, confirming by a different method the observations of others. It might, of course, be said that since the bottle was opened at Mr. Dancer's the air at that place may have communicated them. I answer that, before it was opened, a good glass could detect floating matter, some of it, however, as in the microscope proved, indefinite enough.

Finding this, and fearing that the long time needful to collect liquid from the atmosphere might expose it also to much dust, I used a bottle of about 100 cubic inches dimensions, and putting with it a very little water, not above five cubic centimetres, I pumped out the air of the bottle, allowing the air of the place to enter. This was done six times for each sample, the water shaken each time, and the result examined. This was done with the same bottle that was used in my early experiments with permanganate, and by the same method, except that water instead of that salt was used. At first considerable numbers of moving particles were found; but it was needful to examine the water used, and here occurred a difficulty. It was not until we had carefully treated with chemicals, and then distilled the water again and again, that we could trust it. Particles seemed to rise with the vapour, and if so, why not with the evaporating water of impure places.

Having kept an assistant at the work for a week, and having myself examined the air of three cow-houses, I came to the conclusion that the air of cow-houses and stables is to be recognized as containing more particles than the air of the street in which my laboratory is, and of the room in which I sit, and that it contains minute bodies, which sometimes move, if not at first, yet after a time, even if the bottle has not been opened in the interval. There is found in reality a considerable mass of debris with hairs or fine fibres, which even the eye, or at least a good pocket lens, can detect. After making about two dozen trials, we have not been able to obtain it otherwise. Even in the quiet office at the laboratory there seemed some indications.

I found similar indications in a cow-house with healthy cows; so I do not pretend to have distinguished the poison of cattle plague in these forms; but it is clear that where these exist there may be room for any ferment or fomites of disease; and I do not doubt that one class is the poison itself in its earliest stage. It would be interesting to develop it farther.

I have recorded elsewhere that I condensed the liquid from the air of a flower garden, and found in it, or imagined I found, the smell of flowers. I do not remember that I looked much to the solid or floating particles, thinking them to be blown from the ground; but it does not affect the result, whether they may be found constantly in the air, or are raised by the action of currents.

MICROSCOPICAL EXAMINATION OF THE SOLID PARTICLES FROM THE AIR OF MANCHESTER.

By J. B. Dancer, F.R.A.S.

The air had been washed in distilled water, and the solid matter which subsided was collected in a small stoppered bottle, and Dr. Smith requested me to examine the matter contained in this water. An illness prevented me from giving it so much attention as I could have wished.

The water containing this air-washing was first examined with a power of 50 diameters only, for the purpose of getting a general knowledge of its contents; afterwards magnifying powers varying from 120 to 1600 diameters were employed.

During the first observations, few living organisms were noticed; but, as it afterwards proved, the germs of plant and animal life (probably in a dormant condition) were present.

I will now endeavour to describe the objects found in this matter, and begin in the order in which they appeared most abundant.

1st. *Fungoid Matter.*—Spores or sporidiæ appeared in numbers, and to ascertain as nearly as possible the numerical proportion of these minute bodies in a single drop of the fluid, the contents of the bottle were well shaken, and then one drop was taken up with a pipette; this was spread out by compression to a circle ½ inch in diameter. A magnifying power was then employed, which gave a field of view of an area exactly 100th of an inch in diameter, and it was found that more than 100 spores were contained in this space; consequently the average number of spores in a single drop would be 250,000. These spores varied from 10,000th to 50,000th of an inch in diameter. The peculiar molecular motion in the spores was observable for a short time, until they settled on to the bottom of the glass plate; they then became motionless.

The mycelium of these minute fungi were similar to that of rust or mildew, as it is commonly named, such as is found on straw or decaying vegetation.

When the bottle had remained for 36 hours in a room at a temperature of 60°, the quantity of fungi had visibly increased, and the delicate, mycelial, thread-like roots had completely entangled the fibrous objects contained in the bottle and formed them into a mass.

On the third day a number of ciliated zoospores were observed moving freely amongst the sporidiæ. I could not detect any great variety of fungi in the contents of the bottle, but I cannot presume to say that all the visible spores belonged to one species; and as there are more than 2000 different kinds of fungi it is possible that spores of other species might be present, but not under conditions favourable for their development. Some very pretty chain-like threads of conidia were visible in some of the examinations.

The next in quantity is vegetable tissue. Some of this formed a very interesting object, with a high power, and the greater portion exhibited what is called pitted structure. The larger particles of this had evidently been partially burnt and quite brown in colour, and were from coniferous plants, showing with great distinctness the broad marginal bands surrounding the pits; others had reticulations small in diameter. They reminded me of perforated particles so abundant in some kinds of coal.

The brown or charred objects were probably particles of partially burnt wood used in lighting fires.

Along with these reticulated objects were fragments of vegetation, resembling in structure hay and straw and hay seeds, and some extremely thin and transparent tissue showing no structure. These were doubtless some portions of weather-worn vegetation. A few hairs of leaves of plants and fibres, similar in appearance to flax, were seen, and as might have been expected in this city, cotton filaments, some white, others coloured, were numerous; red and blue being the predominant colours. A few granules of starch, seen by the aid of the polariscope, and several long elliptical bodies, similar to the pollen of the lily, were noticed. After this dust from the atmosphere had been kept quiet for three or four days, animalculæ made their appearance in considerable numbers, the monads being the most numerous. Amongst these were noticed some comparatively large specimens of paramecium aurelia, in company with some very active rotiferæ; but after a few days the animal life rapidly decreased, and in twelve days no animalculæ could be detected.

Hairs of Animals.—Very few of these were noticed, with the exception of wool; of this both white and coloured specimens were mixed up along with the filaments of cotton.

After each examination as much of the drop of water as could be collected by the pipette was returned to the bottle, in order to ascertain if any new development of animal or vegetable life would take place, and the stopper of the bottle was replaced as quickly as possible to prevent the admission of the particles from the air in the room; and I am tolerably certain that the objects named in this paper are those which the bottle contained when Dr. Smith brought it to me.

The particles floating in the atmosphere will differ in character according to the season of the year, the direction of the wind, and the locality in which they are collected, and, as might be expected, are much less in quantity after rain.

The small amount of fluid now remaining in the bottle emits the peculiar odour of mildew, and at present the fungoid matter appears inactive.

For the purpose of obtaining a rough approximation of the number of spores, or germs of organic matter contained in the fluid received from Dr. Smith, I measured a quantity by the pipette, and found it contained 150 drops of the size used in each examination. Now, I have previously stated that in each drop there were about 250,000 of these spores; and as there were 150 drops, the sum total reaches the startling number of $37\frac{1}{2}$ millions, and these, exclusive of other substances, were collected from 2·495 litres of the air of this city*—a quantity which would be respired in about 10 hours by a man of ordinary size when actively employed. I have to add that there was a marked absence of particles of carbon amongst the collected matter.

INSTITUTION OF ENGINEERS IN SCOTLAND.

DESCRIPTION OF A CHIMNEY AT THE WEST CUMBERLAND HÆMATITE IRON WORKS. By W. J. Macquorn Rankine, C.E., LLD.

1. *Object of this Paper.*—The chimney now to be described presents nothing new in design or construction, and is not of any extraordinary size or figure; but as it is a successful example of the application of correct principles and good workmanship to a structure of a useful and ordinary kind, the publication of an account of it may prove serviceable. It has now been in operation for about eight months, and has withstood the gales of an unusually stormy season.

2. *Duty.*—The duty which this chimney has to perform is to carry off the gaseous products of combustion from four blast furnaces, and from various stoves and boilers that are heated partly by burning the inflammable gas from the blast furnaces, and partly by coal. The total quantity of solid fuel consumed may be estimated at about $10\frac{1}{4}$ tons per hour, when all the furnaces are at work.

3. *Figure and Dimensions.*—Above ground, the chimney is a frustum of a cone with a straight batter. Underground there is a plinth or basement, octagonal outside at the ground line and square at the bottom; cylindrical inside, and pierced with four circular openings for flues. The reason for adopting a straight batter, notwithstanding that a curved batter enables certain theoretical conditions to be more perfectly fulfilled, is, that the accuracy of building with a straight batter can be tested at any moment by a glance of the eye, without the aid of instruments. The principal dimensions are as follows:—Height above the ground line, 250 feet; depth of foundation below the ground line (including a layer of concrete 3 feet deep), 17 feet; total height from foundation to top. 267 feet. Inside diameter at top of cone, 13 feet; inside diameter at 2 feet above bottom of cone, 21 feet 10 inches; inside diameter in basement, 18 feet 10 inches; inside diameter of archways for flues, 7 feet 6 inches; outside diameter at top of cone, 15 feet 3 inches; outside diameter at 2 feet above bottom of cone, 25 feet 7 inches; outside dimensions of square basement, 30 feet by 30 feet; outside dimensions of foundation course, 31 feet 6 inches by 31 feet 6 inches; outside dimensions of concrete foundation, 34 feet 6 inches by 34 feet 6 inches. The change from the square to the octagonal shape in the basement is made gradually by stepping the brickwork at the corners.

4. *Thickness of Brickwork, Stability, and Load.*—It had previously been ascertained by observation of the success and failure of actual chimneys, and especially of those which respectively stood and fell during the violent storms of 1856, that in order that a round chimney in this country may be sufficiently stable, its weight should be such that a pressure of wind of about 55 lbs. per square foot of a plane surface directly facing the wind, or $27\frac{1}{2}$ lbs. per square foot of the plane projection of a cylindrical surface, that is to say, a pressure equivalent to the weight of a layer of brick 3 inches deep, and of an area equal to the vertical section of a round chimney, shall not cause the resultant pressure at any bed-joint to deviate from the axis of the chimney by more than one-quarter of the outside diameter at that joint. (See "Proceedings of the Philosophical Society of Glasgow for 1856," p. 14). By calculating according to that principle, the thicknesses of brickwork in the cone were determined to be as follows:—Uppermost 80 feet of height, $1\frac{1}{2}$ brick; next 80 feet of height, 2 bricks; next 88 feet of height, $2\frac{1}{2}$ bricks; lowest 2 feet of height, increasing by steps from $2\frac{1}{2}$ bricks to 4 bricks, in order to spread the pressure on the basement. The *bed-joint of least stability* is 2 feet above the ground line; and the deviation of the resultant pressure from the axis of the chimney at that joint which would be produced by such a wind as has been mentioned is 6 feet 4 inches, being a fraction of an inch less than one-fourth of the outside diameter. The thickness of the arching in the openings for flues is three bricks. The following are the intensities of the mean pressures due to the load on different bed-joints:—At 2 feet above the ground line, 8 tons on the square foot; in basement, at the springing of the arches, 3 tons on the square foot; on the upper surface of the concrete, 2 tons on the square foot; on the ground below, 1·6 ton on the square foot.

5. *Firebrick Lining*—The thicknesses of brickwork already stated *include* the firebrick lining, whose thicknesses are as follows:—In the uppermost 160 feet of the cone, $\frac{1}{2}$ brick; in the lower part of the cone, the basement, and the flue archways, 1 brick. The firebrick lining is bonded with the common brickwork in the ordinary way, the only difference being that the firebricks are laid in fireclay and the common bricks in mortar. The reasons for adopting this mode of construction in preference to an internal firebrick chimney are as follows:—First, when the firebricks are bonded with the common bricks they contribute along with the common bricks to the stability of the chimney, whereas if an internal firebrick chimney had been used an additional thickness of common brickwork would have been required, in order to give sufficient stability to the outer cone; secondly, unless the internal chimney is carried up to the top of the outer cone, there is a risk of damage through the explosion of inflammable gaseous mixtures in the space between; and, thirdly, under the same circumstances there is also a risk of the cracking of the outer cone at and near the upper end of the inner cone through unequal heating at that place. Vertical cracks in a chimney are the more dangerous the higher the level at which they occur; because the safety of the higher part of a chimney depends more on cohesion, and less on weight, than that of the lower part. When such cracks takes place near the ground, they are of little or no consequence. The basement is paved inside with 6 inches of firebrick resting on 6 inches of common brick which rests on the concrete.

6. *Ordinary Brickwork.*—The ordinary brickwork is built of white bricks of very good quality, supplied by the Iron Company. It is built in English bond. In the basement there is one course of headers to every two courses of stretchers; in the cone one course of headers to every three courses of stretchers. Strips of No. 15 hoop-iron, tarred and sanded, are laid in the bed-joints of the cone at intervals of 4 feet in height, with their ends turned down into the side joints. Care was taken to bed the hoop-iron on the common brickwork, and not on the firebrick lining. The length of hoop-iron in each bed-joint in which it is laid is twice the circumference of the chimney.

7. *Mortar.*—In the concrete foundation, the basement, and a small part of the cone, the mortar was made of hydraulic lime. Owing to an unexpected difficulty in obtaining such lime on the spot, it had to be brought from a distance at considerable expense; and therefore the mortar for the rest of the building was made of a very pure lime from the immediate neighbourhood, rendered artificially hydraulic by a mixture of iron scale from the rolling mills at the work: it having been in the first place ascertained that the supply of iron scale could be furnished to the contractor with sufficient rapidity. The following are approximately the proportions of the ingredients of the mortar by measure:—Lime, 2 measures; scale, 1 measure; sand, 5 measures—total, 8 measures. It is scarcely necessary to state that the use of iron scale for hardening mortar and making it artificially hydraulic, is familiar to engineers, architects, and builders in Glasgow and its neighbourhood; but in many other parts of the country that process appears to be less known than it deserves. The principal constituents of the iron scale are probably silica and protoxide of iron; but its action upon lime and the nature of the artificial cement which it forms have not hitherto, so far as I know, been investigated by chemists. Considering the benefits that have arisen from the chemical analysis of other cementing materials, it is much to be wished that some chemist would undertake the examination of this material also.

8. *Cast-Iron Curb—Lightning Conductor.*—On the top of the chimney is a pitch-coated cast-iron curb 1 inch thick, coming down 3 inches on the outside and inside. The lightning conductor is a copper wire rope about $\frac{3}{4}$ inch diameter. It terminates in a covered drain in which there is always a sufficient run of water.

9. *Scaffolding.*—In the construction of the internal scaffolding care was taken that the needles or horizontal beams should be supported wholly by the brickwork, and not by the upright posts; for great danger has been known to arise from the brickwork coming to bear upon the ends of the needles, and through them on the posts, owing to the settlement of the lower part of the chimney.

10. *Precautions against too rapid Building.*—In order that the concrete foundation might have time to harden before being subjected to a heavy load, it was made by the Iron Company themselves before the contract for the chimney was let; for it is known that intense pressure tends to retard the hardening of concrete. The progress of the building was restricted by the specification to a rate not exceeding 6 feet of vertical height per day.

11. *Contract and Execution.*—Tenders were taken from a limited number of builders in the north of England and in Scotland; and the lowest offer was accepted, being that of Messrs. William Wilson and Son, of Glasgow. The work was executed by that firm in a manner that left nothing to be desired.

12. *Cost.*—The following were the amounts of the estimated and actual cost respectively:—Engineer's approximate estimate, £1672; actual cost, including

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* Behind Dr. R. Angus Smith's laboratory.

designing and superintendence, £1560; being at the rate of almost exactly 4*d.* per cubic foot of the whole space occupied by the building, which is 94,000 cubic feet nearly.

13. *Present Temperature and Draught.*—According to the last account, the temperature inside the chimney when doing about three-fourths of its full duty is 490 deg. Fahr.; and the pressure of the draught is $1\frac{7}{8}$ inch of water; which agrees to a very small fraction with the pressure as deduced theoretically from the temperature and the height of the chimney.

14. *Comparison with some other Chimneys.*—The dimensions and stability of the chimney which has just been described are nearly the same with those of the second highest chimney at St. Rollox Chemical Works, built about ten years previously, except that in the older chimney the joint of least stability is 100 feet above the ground. In the great St. Rollox chimney, $455\frac{1}{2}$ feet high from foundation to top, the greatest pressure of wind which can safely be borne is almost exactly the same—viz. 55 lbs. per square foot of a plane surface, or about $27\frac{1}{2}$ lbs. per square foot of the plane projection of a cylindrical surface. The bed-joint of least stability is 210 feet above the ground. In the great Port Dundas chimney, 468 feet high from foundation to top, the bed-joint of least stability is 200 feet above the ground; and the greatest safe pressure of wind is 67 lbs. per square foot of a plane surface, or $33\frac{1}{2}$ lbs. per square foot of the plane projection of a cylindrical surface; so that here it may be considered that there is an excess of stability.

BELFAST NATURALISTS' FIELD CLUB.

THE IRON MINES OF ANTRIM.

By J. S. Holden, M.D.

The iron mines of Antrim occur in the two extremes of the geological formations of the county, viz., the basalt above, and the carboniferous limestones below. The intermediate strata are—under the basalt the hard white limestone, then the greensand, the blue clays of the lias, the keuper marls, and a small appearance of the coal measure.

In an economic point of view all these rocks have been more or less utilized. The basalt, from its decomposition, forms the prevailing producting soil over all Antrim. It is also used for building, and entirely for the macadamizing of our roads. The limestone is triturated into whiting, and burned, to add to the farmers' manure and the builders' mortar. The greensand, being rich in phosphate of lime, has often been a desideratum with manufacturers of artificial manures. The lias has been of little value to any except the palæontologist. The keuper marls of the new red sandstone period form the main site of Belfast, and have yielded the salt mines of Carrickfergus, and brickfields about our neighbourhood. The carboniferous rocks are, unfortunately, either absent, or else impracticably below our reach; they show at the north of the county, and they are fruitful with coal and iron.

Though we economize to the best advantage what rocks we have, it must be confessed that Antrim has not the repute of being a mineral county. The valuable ores which have so materially contributed to England's greatness are either absent or else out of the miner's reach; perhaps the search for them has neither been diligent nor well-directed. The latter, I believe and hope to show, has been the real misfortune—a misfortune which extends not alone to Antrim, but to all Ireland.

In 1855 the annual return of mineral products in Great Britain and Ireland showed England yielding 7,000,000 tons of iron ore; Scotland, 2,400,000; and Ireland only 576, none of which came from Antrim. Surely this return is very far from indicating the relative proportions of the mineral wealth of the three countries.

All basaltic rocks contain some proportion of iron in their essential composition, averaging 9 or 10 per cent.; sometimes small veins or crystals of the magnetic oxide of iron occur. Ferruginous clays, as yellow ochre, are not unfrequent in the glens and hills of Antrim, as well as chalybeate springs. These indications testify to wide diffusiveness of iron throughout the trap districts; but not until lately was it known to exist in such an accumulated form as to invite extensive mining.

When the railway to Ballymena was in course of construction a bed of ochre and lithomarge was cut through near Ballypallady. This has been quarried and shipped to England by Dr. Ritchie for the past six or seven years. The percentage of iron is small, and would not repay working if it were not for the facilities of transit to Belfast which the rail affords.

This clay is useful to mix with superior ores, the silicate of alumina forming a valuable flux, as well as protecting the inner casing of the blast furnace.

There are two quarries at Ballypallady, which in section exhibited some interesting lithological characters. The one on the north bank shows a band of slaty lignite 18 inches thick, above which are 12 feet of decomposing basalt, and below ochre, with boulders passing into lithomarge to a depth of 25 or 30 feet. On the south bank, further down the line, the same arrangement occurs, with the important exception that above the lignite the basalt is here replaced by ochre containing plant remains, and topped with boulders of the drift period showing glacial markings.

About twelve miles north-east of this, and at a height of 500 feet, a much richer iron ore is at present worked. This mine is at Kilwaughter. The basalt overlies it for 20 or 30 feet. At the line of contact the ore is much better than further down, as the seam approaches the underlying basalt, the thickness of the seam being 9 to 12 feet. The top ore consists of a hæmatite clay, with embedded kidney-shaped nodules of magnetic iron ore, having traces, on analysis, of titanic acid. This more or less is present in all the basaltic iron, and adds much to its value, as it increases the facility of puddling, and lessens the loss of the metal, while it improves the quality, and especially of steel.

This mine was first worked on the face by quarrying, but now by mining, level drifts being run in 50 or 60 feet. The ore is carted to Larne, from whence it is shipped to England. Nearer Larne a similar deposit has lately been found at Antiville.

Passing northward along the coast, several indications of iron crop out, waiting exploration. At a height of 700 feet, in the mountains above Carnlough, a very fine ore appears, being almost entirely the nodular or pisiform hæmatite stone. It should yield about 50 per cent. of metallic iron. Nothing has been done in the way of mining here.

At Bay Hill, Glenariff, 800 feet high, an extensive seam of the pisiform hæmatite ranges through the basalt rocks. It is laid bare upon the face of the out-crop for about 70 yards. The strike is east and west. The seam is from 20 to 30 inches in thickness; it is worked both by quarrying and mining; the ore, as excavated, being shot down the cliff in a wooden trough, and then carted to Red Bay Quay for shipping. The analysis of this hæmatite shows it to be a magnetic titaniferous iron ore, and would yield from 50 to 60 per cent. of the metal.

The bold precipitous cliffs of the picturesque Glenariff, heretofore barren, are now becoming fertile sources of mineral wealth. At Parkmore, Mr. Hassard has opened a seam of very superior ore.

Further on, about six miles from sea, and 1000 feet above it, in Glenravel, Mr. Fisher has been working for the past year and a half the most extensive of the basaltic mines. The out-crop is laid bare for more than a mile east and west along the slopes of Slievanee mountain. Four or five level drifts run in for nearly 300 feet, rising with the seam slightly northwards, the basalt, for 600 or 700 feet, rising above. The ore varies in thickness from 12 to 30 inches, an iron clay of 2 or 3 feet underlying. This rich pisiform ore yields as 60 to 65 per cent. of metallic iron. It is carted from the mine to Red Bay Quay.

There can be little doubt that these mines and out-crops indicate the existence of a layer of valuable iron ore ranging through the heart of the basalt floor of our country, and extending over a wide area.

From Ballypallady, at a height of 300 feet, to Slievanee, at a height of 1000 feet, there is not only a gradation of altitude, but of mineralogical character; the ochreous clay changing in its northward ascent into the pisiform magnetic ores.

This metamorphosis can be, I think, traced to its origin by the comparative examination of the mines referred to. When trap rock is long exposed to air and water it crumbles into a rotten friable mass, while mechanical and chemical forces segregate and alter its constituents; the protoxide of iron is changed into the red fur oxide, giving the ochre type to the bed, soluble ingredients being washed away. This conversion may be observed in any fragments of decaying trap, but on a large scale at Ballypallady, where the basalt above the lignite in the north quarry passes into ochre at the south.

In order to account for the pisiform ores, I would offer the following explanation:—

We know that, towards the close of the secondary period, successive volcanic irruption of large quantities of basalt overspread the cretaceous rocks before they entirely emerged from the sea. This was followed by a pause or quiet interval of duration sufficient to allow the surface basalt to undergo the ochreous decomposition, and even on some volcanic islands permit the growth and decay of plants. But again the slumbering fires awoke and belched forth fresh sheets of molten lava, pouring them from their craters in the north of the country over the wild ochre districts southwards. The probable result of this would be the natural roasting and smelting of the metal in the ferruginous clays wherever it came in contact with this lava furnace; and we would expect that that lying nearest the volcanic centres would present the purest and most refined metallic ore, having undergone the longest and fiercest action of the molten torrent, as well as the aggregate pressure of each outflow. The examination of the four mines at present worked, together with the out-crops, tend to support this theory of their origin. The following is a comparative table of the mines:—

	Elevation of Mine.	Superincumbent Basalt.	Metallic Iron.	Pisiform Ore.	Iron Clay.
	Feet.	Feet.	Per Cwt.	Inches.	Feet.
Glenravel, . . .	1000	500	65	21	24
Red Bay Hill, . . .	800	100	55	18	30
Kilwaughter, . . .	500	25	32	12	12
Ballypallady, . . .	300	0	25	0	25

This shows the richest ores are at the highest elevation, and have received the greatest amount of overflowing basalt.

Excluding the Ballypallady clays, the other ores have been mined for a year and a-half, during which time about 13,000 tons of the raw material have been shipped to England, and that at an expense of 4*s.* to 5*s.* per ton for freight alone. The want of facilities for its removal are a present drawback; but the excellence of the quality and the vastness of the quantity will before long bring an increase of capital and energy to the surmounting of all difficulties.

It is much to be regretted that the local absence of coal prevents our own country reaping the full benefits arising from these iron deposits; if otherwise, soon would smelting furnaces spring up and prosper around us. Still something might be done by the substitution of dried peat, which is so abundant on the basalt hills.

The carboniferous iron mines lie between Fairhead and Ballycastle, and are the equivalent of the English and Scotch systems. These are, perhaps, among the most ancient of coal mines in the British Isles. A century ago, when the miners were pushing forward an adit, they suddenly came upon some galleries, with pillars supporting the roof, and among the *debris* were found rude implements for mining, tipped with iron, also remains of baskets. The oldest inhabitants at the time and the oldest records are both silent as to when this working took place.

The line of coast exhibits a most interesting stratification of alternating sandstone, limestone, slates, and coal. The strike of the beds is east and west, and the dip about 1 in 12 southward. These beds are surmounted with toppings of gravel or basalt, and rest upon mica slate.

The iron mines of Antrim are a most important branch of the industry of our country, and one, I think, hitherto little known, when we recollect that, twelve years ago, Ireland only yielded little more than 500 tons, none of which came from Antrim, and that now fully 50,000 tons were shipped within the past year; and there is no reason why this may not be increased tenfold.

There is no better test of the welfare and prosperity of a country than the amount of iron produced and used. Silver and gold pale before the importance of this the noblest of metals. It has crowned civilization after its long struggle upward through the rude periods of stone and bronze, and places first among nations the people who utilize it most.

The mining history of Antrim has been that of all Ireland—deposits of mineral wealth lie hidden throughout the land, waiting the revelations that follow the miner's pick.

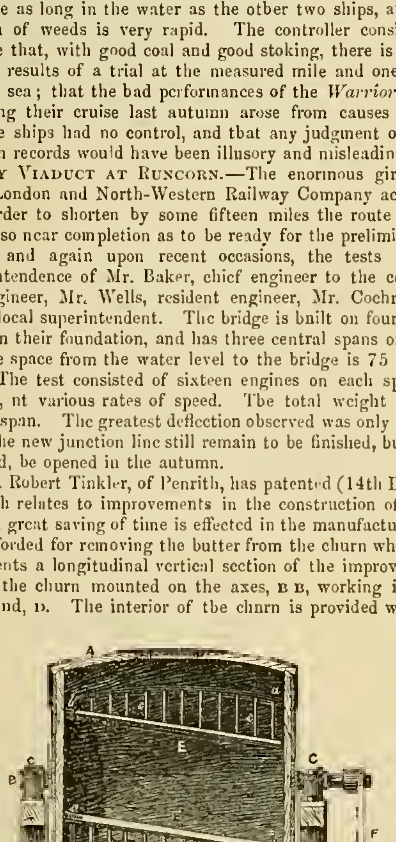
What Ireland needs is the development of her natural resources, the establishment of manufactories, and the utilization of her mineral products.

MONTHLY NOTES.

Warrior, Minotaur, and Bellerophon.—The controller of the Navy reports the result of a recent trial of the speed of these three ships at the measured mile, and for six consecutive hours' steaming outside the Isle of Wight, in fine weather. The speed of the *Minotaur* at the mile was 14·411 knots per hour, but at the six hours' trial only 14·165; of the *Warrior*, 14·079 and 13·936; of the *Bellerophon*, 13·874 and 14·053. The indicated horse-power in the *Minotaur* declined from 6702 at the mile to 6193 in the six hours' trial; in the *Warrior*, from 5267 to 5002; but the *Bellerophon* increased the horse-power from 6002 at the mile to 6199 at the six hours' trial, showing that if the expected horse-power were realized the calculated speed of the ship would be assured. The *Bellerophon* had the disadvantage of having been twenty-one days out of dock when tried for six hours, or twice as long in the water as the other two ships, at a time of year when the growth of weeds is very rapid. The controller considers that these experiments prove that, with good coal and good stoking, there is but little difference between the results of a trial at the measured mile and one lasting for six hours on the open sea; that the bad performances of the *Warrior*, *Minotaur*, and *Bellerophon* during their cruise last autumn arose from causes over which the designers of these ships had no control, and that any judgment on their qualities depen lent on such records would have been illusory and misleading.

The Railway Viaduct at Runcorn.—The enormous girder bridge constructed by the London and North-Western Railway Company across the Mersey at Runcorn, in order to shorten by some fifteen miles the route from London to Liverpool, is now so near completion as to be ready for the preliminary tests of its stability. Once and again upon recent occasions, the tests were conducted under the superintendence of Mr. Baker, chief engineer to the company, Mr. F. Stevens, civil engineer, Mr. Wells, resident engineer, Mr. Cochrane, contractor, and Mr. Ashton, local superintendent. The bridge is built on four buttresses, 167 feet in height from their foundation, and has three central spans of 305 feet each. At high water the space from the water level to the bridge is 75 feet, and at low water 95 feet. The test consisted of sixteen engines on each span, which were moved to and fro, at various rates of speed. The total weight would be about 800 tons on each span. The greatest deflection observed was only 1¼ inch. Some minor works on the new junction line still remain to be finished, but the new route will, it is expected, be opened in the autumn.

Churns.—Mr. Robert Tinkler, of Penrith, has patented (14th December, 1867) an invention which relates to improvements in the construction of rotatory barrel churns, whereby a great saving of time is effected in the manufacture of butter, and greater facility afforded for removing the butter from the churn when formed. The engraving represents a longitudinal vertical section of the improved barrel churn. A is the body of the churn mounted on the axes, B B, working in bearings, C C, secured to the stand, D. The interior of the churn is provided with a number of converging beaters, E E, which, in lieu of being of uniform depth from end to end, are made much deeper at one end of the churn, say at *a*, for example, than at the opposite end, *b*; and it is preferred to dispose these triangular-shaped or tapered beaters in such a manner inside the churn, that the deep and the shallow ends of the beaters will follow alternately at either end of the churn. In the engraving the beaters are represented as being secured between the staves of the barrel itself, by the aid of the hoops; but it is obvious that they may be secured in their places in various ways. The beaters are also represented as each composed or made up of a number of strips or rods of wood, *c*, of gradually increasing or diminishing length, nailed or otherwise secured to longitudinal pieces or strips, *d*, at their opposite extremities; but the invention is not confined to this particular mode of construction. The barrel may be rotated by the handle, F, or otherwise. This churn attracted some notice at the recent show of the Royal Agricultural Society.



Description of a Dolerite at Gleaston, in Lower Furness, by E. W. Binney, F.R.S., F.G.S.—During the last thirty years the tract of land known as the Hundred of Lower Furness has been investigated and described by several geologists. It was one of the earliest fields investigated by the venerable Sedgwick, who has left us a most valuable memoir of his labours in that district. Since then, Mr. Jopling, myself, and Sir R. I. Murchison, and Professor Harkness have published descriptions of the silurian mountain limestone and permian formations of the country. Miss E. Hodgson has also given us information as to the drift deposits overlying the palæozoic strata. Still, notwithstanding what has been done, it may confidently be asserted that the peninsula comprising the southern part of the Hundred of Lower Furness has yet to be carefully examined before its geology can be said to be thoroughly known.

None of the above-named persons appear to have been aware of the occurrence of any trap dykes in this district, judging from their published writings, with the exception of Mr. Jopling, who, in his sketch of the geology of Lower Furness and Cartmel, comprehending the Hundred of Lonsdale north of the sands, published in 1843, when speaking of the geology of Gleaston, says:—"Carboniferous limestone abounds, and in the quarries near the castle are many fossils beautifully preserved in the shale beds between those of the limestone; there is also a vein of trap." At page 72 the same author says, "there are also appearances of trap near Gleaston, associated with limestone breccia."

In the month of October last Miss E. Hodgson was so kind as to send me some specimens of rocks from Gleaston, which puzzled her a good deal. Some of the parties to whom she had sent them called them dolomites, whilst others named them traps and greenstones. To the latter opinion Miss Hodgson, I believe, was inclined to add the weight of her sanction. Not having previously seen, or even heard of, the occurrence of any such rocks in the district where they were said to be met with, I went over to examine them, and having been furnished with information by Miss Hodgson, easily found the place where they are exposed at Gleaston Green. At that time Mr. Jopling's book had not been seen by me. The space occupied by these singular rocks, at least so far as at present exposed, is so limited that all that can be seen is very soon ascertained. Specimens were collected, and a few observations made. The former, by the kindness of my friend Professor Roscoe, F.R.S., were analyzed for me in the laboratory of Owen's College. It is only by the labours of the chemist that geologists can with any certainty decide upon the age and origin of such rocks as those which are met with at Gleaston.

On approaching Gleaston Green from Scales, the mountain limestone appears to occupy the country so far as it can be seen. In a quarry below the old castle on the roadside this rock in the northern part is very hard, and dips to the west at an angle of 25°, whilst in the southern part, where it is softer, it dips in the same direction at an angle of 16°. Owing to the covering of drift, the limestone is not seen nearer to the mill, but it probably extends further in that direction. At a short distance below the mill dark-coloured laminated shales are seen in the bank on the roadside, dipping apparently at an angle to the N.N.W. We then come to the rocks at the end of the Green. They appear to run in an east and west direction, and are not now exposed for more than twenty yards. From north to south they may probably extend about forty yards, but certainly for more than half of that distance, towards the beck, they are not now seen until the land rises on the bluff south of the beck, where they reappear as a reddish and bedded trap ash, having an east and west direction, and dipping N.N.W. at an angle of about 60°. This ash is succeeded by a coarse breccia of a few yards in thickness, so far as exposed, which dips slightly north of west, at an angle of 25°, and then is covered up by grass so as not to be seen; but no doubt, from sections in the adjoining lane and borings made on the rise of the strata, dark-coloured shales occur again, and the dyke most probably intrudes through these shales, which are, in every respect, like limestone shales, but no organic remains were observed in them so as to make us certain of their geological age.

Returning to the north side of the beck, nothing is exposed of the district west of the hard rocks seen on the Green, owing to the thick covering of drift in that direction; but Mr. Hodgson has proved, by a series of bore holes, the occurrence of upper permian sandstone, red shale, and limestone shale—the first to the S.W., the second to the W., and the third to the N.W. of Gleaston; and Mr. Ashburner has proved limestone shale and limestone in bores to the E. and N.E. of the locality where the rock is found. In the bluff on the south side of the stream, as previously stated, the rock appears more like a trap ash of a reddish-brown colour, and exhibits traces of bedding and white lines like carbonate of lime. Immediately adjoining trap ash, and on its rise, occurs the coarse breccia composed of fine-grained siliceous rocks, cemented together with quartz, and like a permian breccia; but although the beds are near together, there was not evidence to show whether the trap ash gradually passed into the breccia or intruded through it; still the breccia appeared to dip in the same direction, but at a much less angle, namely, 25° to a little west of north. This is a very interesting fact to prove: for if the rock graduates into the breccia, it would appear to be of permian age, and most probably a melaphyr; but if it is intrusive, as the evidence on the whole appears to prove, all we can say is that it is of later date.

The breccia is composed of angular pieces of a fine siliceous stone, of a pink colour, more resembling quartzite than anything else, cemented together by small quartz crystals, and containing minute quantities of protoxide of manganese. The form of the fragments is very like that of the rocks in the permian breccia of Rougham Point, near the mountain limestone of Humfray Head, and there consisting for the most part of the neighbouring mountain limestone; but no limestone has yet been met with in the Gleaston breccia, as might have been reasonably expected, and the pink quartzite is a rock hitherto unknown in the district. The permian breccia, so far as my experience goes, although sometimes containing volcanic ash, are composed of the rocks now found in the neighbourhood where they occur, and nearly always vary with the older geological rocks of the district. The composition of the Gleaston breccia makes me hesitate in designating it as permian, as it may be some rock altered by the dyke.

The rock in its best state of preservation is remarkably hard, of a reddish brown colour, has a moderately straight fracture, and a pinkish white streak, and its specific gravity is 2·92.

Three average samples of the rock were taken, two from the north and one from the south side of the beck. All of them were more or less decomposed by exposure to air and moisture, but No. 26 much less than Nos. 23 and 24. Professor Roscoe on analysis found their present chemical composition to be as follows:—

	South of Stream, No. 23.	North of Stream, No. 24.	North of Streams, No. 26.
Silica,	45·54	50·96	51·10
Peroxide of Iron,	24 76	24·20	21·58
Alumina,	7·70	14·48	9·40
Lime,	13 84	7 32	6·24
Magnesia,	0·57	0·55	1·33
Carbonic Acid,	2·78	1·90	2·70
Alkalies, Water (by difference),	4·82	0·59	7·65
	100 00	100·00	100·00

The only rock which I know of a similar composition, is a probable variety of green earth, resembling a decomposed pyroxene, described by Macfarlane in the *Canadian Naturalist*, New Series, vol. iii., No. 1, page 5, in a paper on the cupriferous bed of Portage, Lake Michigan, which consists of—

Silica,	46 48
Alumina,	17·71
Protoxide of Iron,	21·17
Lime,	9·89
Magnesia, trace,	—
Alkalies (by difference),	1·97
Water,	2·78

Dr. David Forbes, F.R.S., to whom were forwarded small specimens of the rocks and the above analysis, kindly informed me that the rocks were so much decomposed that it was difficult to pronounce with certainty as to what they were, but he was inclined to think that they were an intrusive dolerite of carboniferous age, rather than a melaphyr. The iron had been changed from a protoxide into a peroxide, and the lime had resulted from the decomposition of a lime felspar. As Mr. Forbes had found the presence of titanium united with iron in all the carboniferous dolerites he had examined, I took several ounces of the three samples above given, and having heated them in a crucible so as to convert the iron from a peroxide into a protoxide, extracted it by a magnet. About half an ounce of this iron was very carefully examined by Mr. Thorpe in Dr. Roscoe's laboratory, especially for titanic acid, and no trace of that substance was found. He used the test with microcosmic salt, having separated iron and silica. The absence of titanium in the rock would lead us to believe that it was of later origin than the carboniferous age; but if traces of that metal had been found, it would not only have settled the question as to the age, but it would have shown a connection with the hæmatite iron ores of Whitehaven and Ulverston, all of which contain more or less of titanium, as proved by the deposits of that metal found on the sides of old furnaces where hæmatite has been smelted. Is the rock of permian age? It is certainly not much unlike the melaphyr of the German geologists, and the breccia near the dolerite is not greatly different from that of Ballochmyle, described by Mr. A. Geikie, F.R.S., in the *Geological Magazine* for December, 1866, but we could not obtain direct evidence that the breccia gradually passed into the trap; the latter appeared to protrude through it, but certainly the trap and the breccia dipped in the same direction, the one at about 60° and the other at 25° a little west of north. This point can only be satisfactorily determined by cutting a trench and showing the contact of the breccia with the trap. The extent of the dyke can only be traced for a few yards east and west, as previously stated, and none of the hæmatite iron deposits, so far as known, have been found south of it. Its age also appears to be more recent, even supposing it to be permian, than those deposits, which for the most part must be considered of carboniferous age. The occurrence of this trap might have been considered to have some connection with the deposition of the iron had it been of carboniferous age; but it is evidently more recent, and therefore could have had nothing to do with it further than disturb or displace it.—*Lit. and Phil. Society, Manchester.*

Cutting Glass.—*Les Mondes* says the use of hot air or gas for cutting or dividing glass is a new and useful invention already utilized by the Crystal Company of Balcarat. The hot gas issues from a pointed or flattened tube, and is projected directly upon the object to be cut, which is placed in close proximity to the tube and made to revolve upon its axis. A narrow circle of heated glass is thus formed upon the object in question, which, being damped immediately afterwards, causes the glass to divide at the part thus heated. The operation is more rapid and effectual, we are told, than any means hitherto employed for this purpose.

Messrs. Gagnage and Gignon, with the co-operation of M. Poinsot, have succeeded in extracting from the *Zostera marina* fibrous cellulose, which enters into the preparation of packing paper and even of white paper. Its easy manufacture is by treating it with soda, much washing, and the ordinary process of bleaching with hypochloride of chalk. The product thus obtained contains only faint traces of oxide of iron: in this respect it is purer than straw pulp, but less pure than wood pulp completely bleached.

Boot Lasts.—Mr. G. M. Wells, of Belitha Villas, Barnsbury, has patented (17th October, 1867) certain improvements which relate to the sockets or holders for the standards or supports employed in holding the lasts during the process of making and finishing boots and shoes, and has for its object the affording facility for placing or adjusting the last in any convenient position required by the workman. According to this invention, it is proposed to mount the standard which carries the last in a revolving socket, whereby the last is free to be rotated horizontally or angularly, so as to bring any side in front of the workman. This revolving or rotating socket may be used, either in conjunction with the ordinary standard, or with a standard cast in one piece with a portion of the last. The revolving or rotating socket may be made in various ways. According to one mode of construction, it is proposed to cast the outer ring or surrounding metal, forming the fixed part or holder of the socket, round the revolving block containing the socket hole, such block being by preference of a slightly spherical shape, in order to increase its strength and to keep it in its place in the outer ring. According to another modification, the movable or rotating block is of a perfectly spherical form, and is cast or contained in an outer fixed support or holder, within which it is free to rotate in any desired direction, after the manner of a ball and socket joint. A socket or opening is made in the spherical block, and a corresponding opening is made in the bottom of the outer fixed holder; the standard, when adjusted into the block, may either pass through it, so as to cause its protruding end to enter the opening in the fixed holder, in which case the rotating block will be locked and the standard maintained in a fixed vertical position; or the standard may be elevated slightly, so as to withdraw its extremity from the opening in the fixed holder or case, whereupon the spherical block with the standard will be free to be adjusted or turned to any desired angular position; suitable notches or recesses being formed, if desired, in the surrounding rim or edge of the outer case or holder, to support the standard when adjusted or turned over into an angular or horizontal position. The improvements will be fully understood on reference to the accompanying engravings, representing two modifications of the socket holder, which is constructed in two parts, the outer one, A, fig. 1, being stationary and secured to the work-bench, or other convenient support; whilst the inner one, B, which constitutes the socket proper (being provided with a hole, *a*, for the reception of the lower end of the standard, C, of the last), is free to rotate on a vertical axis inside the fixed or surrounding socket, A. In order to keep the loose part, B, inside the part A, an internal enlargement of the aperture in the part A is formed, and the inner part, B, cast therein, the part A, in fact, serving the purpose of a "chill" during the operation of casting. Fig. 2 represents a sectional elevation of a modified form and construction of socket or holder, which is called the finishing socket, wherein a universal adjustment of the last is provided for; the inner loose portion, B, of the holder, which forms the socket proper, having the hole made therein for the reception of the lower end of the last. The standard C is of a spherical shape, and is cast inside the spherical chamber of the fixed part, A, of the holder, which it consequently fits with accuracy, but easily, so as to enable it to turn inside the part A, and assume any desired position. A number of notches or recesses, *b b*, may be made in the surrounding raised portion of the holder, A, into any one of which the standard may be laid, so as to incline the last to an angle. By turning the standard, C, with the spherical socket, B, the toe, heel, or side of the last may be presented to the workman as required; and if it be desired to maintain the standard and last in a vertical position, it is simply requisite to drop the lower end of the standard through the central square opening, *c*, made in the bottom of the outer fixed part, A, of the holder. The notches or recesses, *b b*, are of different depths, in order that the

Fig. 1.

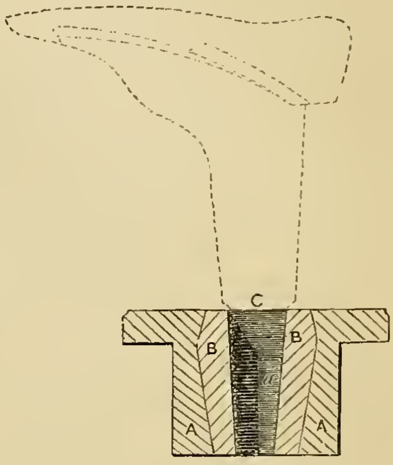
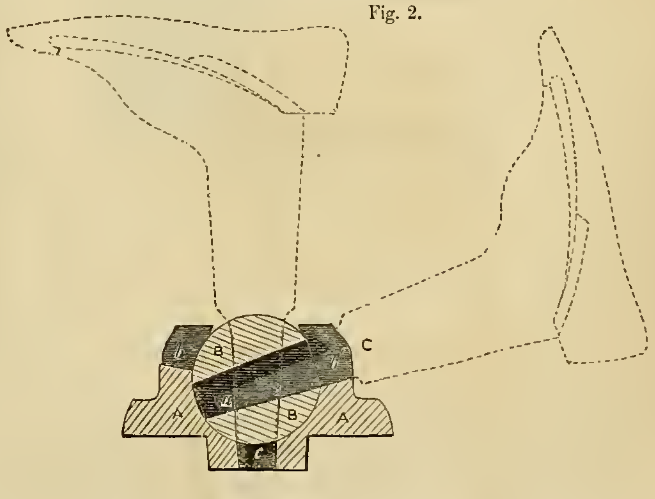


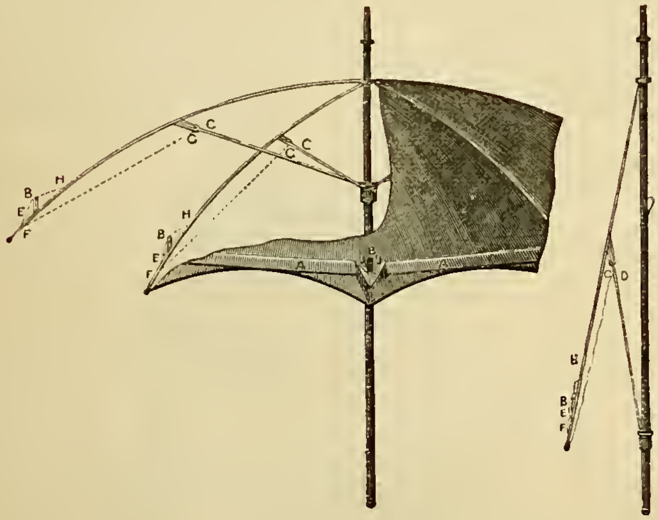
Fig. 2.



standard, c, may assume different angles, and one of such notches, b, is V-shaped at the bottom, in order to admit of any one of the corners or angles of the standard resting therein, the remaining notches being flat-bottomed, to take the flat sides of the standard. In lieu of casting the inner or movable part of the socket inside the outer part, the outer part may be cast round the inner part.

The London Association of Foremen Engineers.—The thirty-fourth half-yearly meeting of members of this Institution took place on Saturday the 4th ult., at the George Hotel, Aldermanbury, City. The chair was occupied by the president, Mr. Joseph Newton, of her Majesty's Mint, and the attendance was large. The sitting was mainly devoted to business connected with the society, and after the election of several new associates, the auditors, Messrs. J. Irvine and J. Humes, presented their report and the balance-sheet for the half-year just ended. From those documents we find that the number of ordinary members (foremen of engineers) at present on the books of the Association is precisely one hundred, and that of honorary members (employers of engineering labour and other scientific gentlemen), fifty-three. The general fund invested or in the treasurer's hands amounts to £431 2*s*. The superannuation fund, projected for the partial support of decayed foremen, has reached to £903 18*s*., whilst the fund for the assistance of the widows and orphans of deceased members stands at £12 4*s*. only, and is far too small for its purpose. After some discussion, both the report and balance-sheet were unanimously accepted. Messrs. Salmon, Smith, and Vinicombe were subsequently chosen as committee-men in lieu of three others, who retired by rotation, and Mr. Bunt was appointed co-auditor with Mr. Irvine for the current half-year. The chairman finally appealed to the members to exert themselves in the production of papers for the monthly meetings of the coming session, and expressed some dissatisfaction as to the paucity of volunteers in that direction during the half-year which had just elapsed. As the transactions of the Association were now regularly printed, it was the more desirable that abundant material should be forthcoming. After announcing that Mr. G. F. Ansell, an honorary member of the society, would, on the 1st of August next, read a paper and otherwise explain and illustrate certain new processes for the manufacture of sugar, the chairman closed the proceedings.

Umbrellas.—M. Felix Asselin, of Paris, has invented a very ingenious arrangement for preventing the inconvenient dropping of water from the circumference of umbrellas when used in a heavy fall of rain, whereby portions of the garments, although protected by the umbrella itself from the direct action of the rain, are frequently soaked by the water which flows from the edge of the umbrella. The essential feature of the invention consists in the adaptation to the exterior of umbrellas of a gutter extending entirely round the umbrella, at or near its circumference, such gutter opening at one portion to a discharging spout, which allows the water accumulating in the gutter to be discharged at one definite point in the umbrella's circumference, in lieu of continually dropping or running from all parts of the same. A band or ribbon of say one inch to one inch and a quarter in breadth, and of a like material to the covering of the umbrella, is closely and firmly stitched along its lower edge to the exterior surface of the covering. This band or ribbon should be so disposed and shaped at the junction with the ribs, that when the umbrella is open the upper edge of the ribbon will stand out at an angle from the surface, and so form an open gutter all round. At each rib a small hinged support is provided, composed of wood, metal, or other rigid material, to which support the ribbon is secured. These supports, when the umbrella is closed, lie close against the ribs, being made to assume that position either by a spring or by a piece of vulcanized india-rubber secured to its upper end and to the rib a few inches higher up. The act of opening the umbrella causes the supports above referred to to assume an angular or nearly upright position, and thereby maintain the ribbon gutter open, and this is accomplished by the aid of cords attached to the inner stays, passing through an eyelet hole below the gutter and then passing up to the top of each support. The arc described by the inner stays when the umbrella is being opened tends to tighten or draw the several cords, and thereby opens out the supports to which the ribbon gutter is secured. It is obvious, however, that various simple mechanical contrivances may be employed for opening and closing the supports of the gutter by the opening and closing of the umbrella; and therefore the arrangements above described may be taken as an example only of one mode of effecting this operation. The arrangement will be fully understood by reference to the accompanying engravings, in which A represents the band or ribbon, B the simple support, B′ the triangular support, C the stretcher in its open state, D the stretcher closed, E a piece of twist or cord, F eyelet hole, G point of attachment of the cord E, H india-rubber cord, I a spout, J wire support; *a c* is the side of the support, B′, which is stitched to the umbrella, and *b* the corner of the support, B′, which is attached to the top part of the ribbon, A.



Water Velocipede.—An ingenious application of the principle of the velocipede to water-locomotion may now be seen on the Lake of Enguien, near Paris. The form of this new species of naval construction is that of the twin ship tried some years back on the Thames, the motive power being placed in the middle instead of on each side as in ordinary paddle steamers. A pair of hollow water-tight pontoons, about 12 feet long, 10 inches wide in the thickest part, and tapered to a point at each end, are fastened together about 20 inches apart by transverse bars near the extremities. In the centre is placed the seat, rising about 2 feet above the water, and supported by iron rods. In the front is the paddlewheel, about 3 feet in diameter and 8 inches broad, provided with sixteen floats, the axle turning on stout iron uprights, and the rotary motion being obtained from cranks worked by the feet. This little vessel is steered by rudders at each of the sterns, and moved by lines. The pontoons being made of thin mahogany planks, the whole construction is very light, and glides along with astonishing rapidity. This water velocipede, having been built as a first experiment, is no doubt susceptible of improvement in some of its details, but the principle may be already pronounced a complete success. The inventor is M. Thierry, an architect, of Paris.—*Galignani.*

The Mont Cenis Tunnel.—During the present year to 30th April, the total advancement made at the Mont Cenis tunnel has been 421·35 metres, of which 199·50 was at the Italian side, at Bardonnèche, and 221·85 metres at Modane on the French. During the month of April, the total progress made was 109·35 metres, of which 46·40 metres were driven at the Bardonnèche end, and 62·45 metres at Modane. The position of the tunnel up to the 30th April was as follows:—

	Metres.
South end, Bardonnèche, ...	4,924
North end, Modane, ...	3,344
Total length of tunnelling, ...	8,268
Remaining to be driven, ...	3,952
Total length of tunnel, ...	12,220

A "Break Down" in Mid-Ocean.—(From a Correspondent.)—The Steamship, *Great Republic*, which sailed from San Francisco for Yokohama on 7th March, after fourteen days' running, met with a rather remarkable accident, being no less than the snapping of her starboard shaft. This shaft is really outside the ship, and as the wheels cost 20,000 dollars each, it was an object to save the one rendered useless, as well as to get into a position that would admit of the other wheel being used. The total weight of the wheel and shaft exceeds 104 tons; this had to be thoroughly severed from its connections, and made fast. To most people such a feat would seem an impossibility, but it was not only undertaken but fully accomplished. In thirty-one hours from the accident the ship was again on her voyage. The arrangements for overcoming the difficulties were promptly planned and diligently executed. All the hands were immediately turned to, and the entire ship's company, composed of 125 men, were incessantly at work. They were divided into two gangs, one in the mate's department to work upon the sails and rigging, the other in the engineer's department to work upon the wheel and broken shaft. Masts which were housed, full sets of yards which were on deck, were sent aloft, and everything got ready for putting upon her the greatest possible amount of sail. At the same time the buckets were taken off from all that part of the starboard wheel which was not submerged, and hoisted on deck. The shaft then stood with the fractured part uppermost, and it became necessary to turn the wheel sufficiently to bring the remaining buckets out of water, and also to bring the remaining third of the shaft uppermost, so as to get at it to mark it with a cold chisel, preparatory to completing the fracture. The various parts of the starboard wheel were then severally lashed to the timbers of the wheel-house, with chains and hawsers to hold it immovable, and to prevent it from falling into the sea when detached. The starboard wheel being lashed as nearly immovable as possible, the engine was started ahead, so as to revolve the shaft just three inches, and by so doing the remaining third was fractured. The two broken ends now overlaid each other, and it became necessary to separate them. In order to do this the outboard end of the shaft and wheel was raised by hydraulic jacks, and the broken shaft and wheel launched off from the ship about eleven inches, when the inboard end was allowed to drop just below the other piece then in the journal; and after chafing plank had been placed between it and the ship's side, it was brought close in to the vessel and finally secured, the outer end having been let back into its former place. In this condition she got under way with the wind E.N.E., coming round with all her head sails set and her port wheel turning slowly. Every one on board had supposed that in this condition it would have proved a difficult task to steer the ship, and that she must necessarily carry a weather helm to a remarkable degree. But she was found to be going six knots an hour, and carrying her rudder very nearly amidship. The voyage was continued in this manner, the ship running from 130 to 177 miles per day; and she reached Yokohama in safety, having run 2000 miles in her crippled condition. This feat of the *Great Republic*, which was accomplished in fourteen days, may be set down as an original occurrence in steam shipping. The *Great Republic* could hardly have broken her shaft in a spot more remote from any assistance, or further from any port of repair. She did not see a sail on the voyage. Yet, notwithstanding all these circumstances, the above is her record, which cannot but prove most satisfactory to her builders, and the Pacific Mail Steamship Company, her owners.

Filtering Paper.—The manufacture of paper for filtering purposes requires the employment of textile fibres from which all glutinous matter has been removed, but which are sufficiently powerful to resist and to support liquids without breaking or collapsing. For this purpose well-washed and bleached rags are employed, which have been submitted to a moderate action of chloric, or, what is better, hypochloride of lime; the pulp is freed from all calcareous compositions through chlorohydric acid, and submitted to very abundant and complete washings in the purest water obtainable; finally, the pulp is made into sheets of considerable thickness, and quickly dried, in order to be resisting and easily permeable. In this manner gray filtering paper is also prepared; that is, however, more spongy, filters more quickly, and is made of a mixture of cotton rags with common woollen ones; but washing and bleaching with chloric is omitted, as it would dissolve or decompose the wool. In spite of abundant washings of this mixed pulp, it communicates to certain liquids filtered through it a peculiar odour, and even introduces foreign substances into them. The learned and illustrious Swedish chemist, Berzelius, has given his name to the purest paper which can be employed for the most delicate analyses of laboratories. His process is thus described:—As primary matter new linen rags are employed, which have been bleached in a field, by the ancient practice of dew-bleaching. The damp rags are put into boxes, where they undergo, as in the ancient paper-mills, the effects of fermentation, which separates the fibrous threads, and alters and renders soluble several pectic compositions and other glutinous matters. But the reactions must be carefully watched, or the purifier might attack the cellulose itself. The rags thus prepared are then submitted to a strong soda lye and afterwards reduced to pulp; the pulp is then treated with chlorohydric acid with ten times its volume of water, and washed till all acidity has disappeared.—*Paper Trade Review.*

Dynamite.—In our last part we gave some results of Scotch experiments upon this new blasting agent. Some experiments have since been made upon it at the Merstham Graystone lime works, Redhill. The causes which render gunpowder and nitro-glycerine so dangerous to handle, or convey by the common modes of transit, have no effect upon dynamite. Nitro-glycerine explodes at 240 degrees Fahrenheit, gun-cotton at 400 degrees, gunpowder at 600 degrees, a common fire at 1200 degrees; but a much higher temperature than this is required to ignite dynamite, which must be placed somewhat between 1400 and 3280 degrees. A thin deal box containing 10lbs. of the compound was placed over a raging fire; the box was consumed, but there was no explosion, and the dynamite mingled harmlessly with the ashes. It was in other ways placed in immediate contact with fire, with the same results. Gunpowder was exploded near it without effect. The superiority of the material over the dangerous explosives as to which concussion would be certain destruction, was acknowledged by several practical persons present connected with the carrying trades. Ten lbs. of dynamite were inclosed in a second deal box, and hurled from the top of a cliff. It fell 60 feet upon the rocks below, with no more signs of explosion than would be caused by the fall of a brickbat. Equally striking were the illustrations given of its deadly strength. A cartridge filled with dynamite was placed upon a two-inch oak plank. A fuse with a strong percussion cap was attached to it and fired, and the plank was split in several places, and had a hole knocked through it. The percussion cap is the explosive agent, and it is claimed that nothing else, so far as is known, will do the work. In this instance the work was done most effectually, although the cartridge, which was about the size of a man's finger, was laid loosely on the plank. A large block of granite, about a yard cube, was shivered by like treatment. A block of wrought iron, with an inch bore-hole, but without either plug or tamping, shared the same fate, as did a wrought-iron cylinder with a charge laid loose on the top. The rocks were bored 15 feet deep, and fired, with an effect that startled the quarrymen present, not because of the loudness of the report so much as because of the immediate and extensive character of the blasting. Other experiments demonstrated the great velocity imparted to fragments of shells charged with dynamite, and its adaptability to distress signals.

Proposed Exhibitions at Lyons.—It is said that measures are being taken for the holding of industrial, artistic, and agricultural exhibitions at Lyons next year, to open in May, and close in August. The three exhibitions will be separate from each other; the first to be held on the new Cours Napoleon, the second in the Museum or Palais des Arts, and the third in the park of the Fête d'Or. A great festival of the orpheonists and of the musicians of the Rhone and the neighbouring departments, is proposed to be held at the same time.

Porcelain and Pottery.—Mr. W. H. Kerr, of Cloutarf, has patented (16th December, 1867) an invention which relates to the preparation of all materials or compounds used for the manufacture of porcelain and pottery, by what is known as the dry-pressed system, that is to say, by the pressure of such materials into the required shape in a dry state; and consists in the preparation of such materials or compounds by calcining, or firing or fretting the same in kilns or furnaces, or in any other convenient manner, previous to such materials being pressed into shape, as above described. In practically carrying out the invention, any or all materials intended to be used for the purpose herein-before referred to, are either before or after (as occasion may require) grinding, calcined or fretted together or separately in articles called "saggers," which are placed in kilns or in what is generally known as Siemens' regenerative furnace, or in any other furnace or kiln suitable for such purpose, that will bear the action of fire. The said materials, after being so calcined or fretted, are then to be further ground or worked into a pulverized state for the purpose of pressure, as above-described, in suitable moulds or matrices, according to the shape of the articles to be produced.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

16th June, 1868.

1956 W. and O. Brooke, Manchester—Healds or heddles
1957 W. Rowan, Belfast—Hackling flax
1958 R. Wappenstein and R. Ray, Manchester—Registering the number of passengers travelling on omnibuses
1959 D. Elder, Newcastle-upon-Tyne—Dredging machines
1960 T. Whitehead, Holbeck—Combing wool
1961 J. J. and J. Booth, Rodley—Dressing stone

17th June, 1868.

1962 M. Demmer, Paris—Dial or indicating needle case
1963 J. P. Wills and E. H. Cardell, South Petherwin, and T. F. Wills, Bayswater—Mowing or reaping grass or grain crops
1964 D. Mitchell, Macclesfield—Figured cloth
1965 G. B. Turrell, New York—Coolers for beer
1966 W. Betts, Hastings—Weighing carriages
1967 T. Comfield, Chigwell—Brakes for railway carriages
1968 J. M'Leod, Renton—Dyeing yarns
1969 W. Carr, Manchester—Hinges
1970 J. C. Walker, Strand—Baking powder
1971 W. and J. Rhodes, Bradford—Safes
1972 A. M. Clark, Chancery Lane—Purifying ceramic.—A com.

18th June, 1868.

1973 W. Thomson, Normanton, and J. Crossley—Barrow-upon-Soar—Rails and chairs for railways
1974 J. and E. Lumley, Kirk Hammerton—Pills
1975 A. Ridgway, Upton—Hay rakes
1976 A. Cochran, Kirktonfield—Finishing woven fabrics
1977 C. Attwood, Walsingham—Moulds for casting
1978 G. F. Redfern, Finsbury—Drawing rovings.—A com.
1979 T. C. Hide, Fenchurch Street—Dressing flax
1980 C. Hengst and H. Watson, Fulham—Gas for lighting and heating
1981 W. S. Carr, New York—Water closets
1982 J. Hemington, Chatteris—Sharpening the cutters of reaping and mowing machines

19th June, 1868.

1983 E. R. Kaulbach, Strand—Producing direct rotatory motion
1984 A. Mackie, Warrington—Setting and distributing type
1985 J. Perry, Rathdowney Brewery—Packing bottles
1986 D. and J. Greig, Edinburgh—Lithographic printing machines
1987 W. E. Newton, Chancery Lane—Aerial navigation.—A com.
1988 M. P. W. Boulton, Tew Park—Motive power
1989 F. B. Daering, Westminster, and R. H. Twigg, East India Avenue—Boring stone
1990 A. J. B. Thierry, Paris—Marine velocipedes
1991 T. Heppell, Pelaw Main Collieries—Miners' safety lamps

20th June, 1868.

1992 G. Owen, Islington, Chessboards
1993 W. Umpherston, Loanhead—Steam engines
1994 G. H. Midwood, Manchester—Treatment of certain waste yarns
1995 G. Richardson, Whitefield—Looms for weaving
1996 A. A. Common, Regent Park—Stench traps for sinks
1997 H. W. Hart, Bayswater—Pots for containing tea and coffee
1998 J. Hadley, City Flour Mills—Cleaning grain
1999 W. L. G. Wright, Glasgow—Propelling ships
2000 C. H. Murray, Southwark—Device for uniting the ends of straps and belts
2001 J. Bonnall, Grantham—Thrashing machines
2002 J. Shelmerdine, W. Walker, and E. Holt, Manchester—Valve gear for steam engines
2003 W. Bayliss, Wolverhampton—Wrought-iron hurdles
2004 S. Bowen, C. Glover, R. H. Davis, T. Standford, and T. Scott, Birmingham, and A. M. Bell, E. Sheldon, W. Farmer, L. Maskall, E. Coburn, and J. C. Cole, Smethwick—Cutting screws

22nd June, 1868.

2005 V. De Stains, Shepperton Villas, N.—Propelling boats or other vessels
2006 R. and W. K. Austin, Glasgow—Rotatory engines
2007 W. Tongue, Kennington—Preparing fibrous materials for spinning
2008 E. T. Hughes, Chancery Lane—Polishing needles.—A com.
2009 E. T. Hughes, Chancery Lane—Metallic cartridges.—A com.
2010 W. E. Gedge, Strand—Indicating whether the doors of railway carriages are securely fastened.—A com.
2011 W. A. Gilhee, Finsbury—Cards for carding.—A com.
2012 M. Gray, Highbury Hill, and L. Gibson, Silvertown—Covering electric conductors
2013 A. M. Clark, Chancery Lane—Winding thread
2014 C. Whitehouse, Bridgtown—Mill bills for dressing millstones
2015 G. Taylor, Bradford—Boots and shoes
2016 J. and J. Hayes, Elton—Actuating straw shakers
2017 J. H. Johnson, Lincoln's Inn Fields—Producing colours for dyeing and printing.—A com.

23rd June, 1868.

2018 C. M. H. Downing, Hyde Park—Fire-arms
2019 H. A. Bonneville, Paris—Carding and spinning wool.—A com.
2020 J. and A. Douglas, Stranraer—Reaping and mowing machines
2021 C. Johnson, Oxton—Boilers for heating water
2022 A. V. Newton, Chancery Lane—Folding chair.—A com.
2023 A. V. Newton, Chancery Lane—Brick machine.—A com.
2024 P. Brown, Houghton, and B. Brown, Huntingdon—Correcting irregularities of millstones
2025 C. T. Burgess, Brentwood—Reaping and mowing machines
2026 W. Sowerby, Surat—Rails for common roads

24th June, 1868.

2027 D. M. Giacometti, Paris—Economizing motive power.—A com.
2028 C. T. Sutton, Holloway Road—Educational purposes
2029 B. T. Moore, Islesworth—Protecting water pipes
2030 W. Carr, Manchester—Carriages
2031 J. Gregory, Bristol—Charring
2032 N. C. Underwood, Gorton—Carding engines
2033 W. H. Crocker, Liverpool—Cartridges
2034 J. Mitchell, Bradford—Furnaces
2035 S. Owens, Whitefriars Street, and T. Patterson, Kennington—Winches and cranes
2036 J. Lambert, Nottingham—Ornamenting lace
2037 M. and J. Mackie, Kilbirnie—Steam boilers
2038 T. Restell, Birmingham—Military and sporting guns
2039 G. Smith, Upper Thames Street—Ventilating boots and shoes
2040 E. B. Wilson, Stockton-on-Tees—Furnaces
2041 R. Elsdon, Brockham—Burning lime

25th June, 1868.

2042 E. Mucklow, Bury—Utilizing refuse tanning matters
2043 J. Briggs, Barrow—Ingot moulds
2044 J. Jack, Liverpool—Auxiliary screw propellers
2045 E. Lever, Denton—Coating of woven fabrics
2046 A. D. Aulton, Walsall—Motion to sewing machines
2047 J. G. Garrard, Harlow—Rick cloths
2048 Rev. H. Highton, Brighton—Artificial stone
2049 G. T. Bousfield, Brixton—Fire-arms and cartridges.—A com.

26th June, 1868.

2050 J. Hine, Cockermouth—Dressing millstones
2051 C. Hastings, J. Briggs, J. Law, Bradford—Finishing yarns made of wool
2052 C. D. Abel, Chancery Lane—Cleansing bottles.—A com.

2053 T. Dodd, Crumlin—Covering railway trucks and waggons
2054 M. Burke, Liverpool—Folding chairs
2055 T. Winder, Liverpool—Marine chair stoppers
2056 R. Clough, Keighley—Looms for weaving
2057 S. S. Maurice, Monkwell Street—Fastening for neckties.—A com.
2058 J. Taylor, Staleybridge—Preparing cotton
2059 A. Thomson, Southampton—Water-closets
2060 F. H. Holmes, Gravesend—Electro-magnetic machines
2061 L. Thomas, Leadenhall Street—Distilling pure water from salt water
2062 A. H. Brandon, Paris—Metallic cartridge shells and heads.—A com.
2063 T. C. Branchflower, Great Yarmouth—Packing preserved meats for sale
2064 A. H. Brandon, Paris—Spinning hemp.—A com.

27th June, 1868.

2065 P. R. Hodge, Adelphi—Hydrocarbonaceous fluids
2066 R. Warry, Gillingham—Breech-loading fire-arms
2067 J. Baggs, High Holborn, and F. Braby, Camberwell—Extricating and condensing of ammonia
2068 C. Ma her, Salford—Excavating or loosening soil
2069 J. Bowker and J. Ivers—A slip for raising on the line of rails engines and carriages
2070 J. Tyson, Spark Bridge—Bobbins
2071 G. M'Culloch, Manchester—Thread-polishing machines
2072 W. F. Deane, Farnworth—Obtaining oxide of manganese
2073 H. Large, Notting Hill—Bricks
2074 G. H. Wilson, Golden Square—Cases for holding tape measures
2075 J. Morris, Middlesborough—Steam boilers
2076 R Smith, Islington—Preventing the fouling of iron
2077 W. C. Stiff, Birmingham—Breech-loading fire-arms
2078 W. R. Lake, Chancery Lane—Dyeing textile fabrics.—A com.

29th June, 1868.

2079 S. Hannah, Haughton-le-Skerne—Fluid meters
2080 J. Wardman and J. and F. Baldwin, Sandbeds—Steam boilers
2081 W. Baxter, D. Waring, and J. S. Wooller—Drying textile fabrics
2082 R. Shaw and J. Clayton, Higher Walton—Looms for weaving
2083 H. Jewitt, Leighton Road—The needle gun.—A com.
2084 A. V. Newton, Chancery Lane—Liquid meters.—A com.
2085 C. E. Brooman, Fleet Street—Bleaching fabrics.—A com.
2086 G. H. Wilson, Golden Square—Watches
2087 C. E. Brooman, Fleet Street—Shawls.—A com.
2088 W. R. Lake, Chancery Lane—Burning the vapour of naphtha.—A com.

30th June, 1868.

2089 F. J. Drechsler, St. John's Wood—Boilers and furnaces
2090 G. Glover, Pimlico—Combustion of naphtha.—A com.
2091 G. Bower, St. Neots—Boilers for heating purposes
2092 J. Randall and W. R. Crabb, Battersea—Self-propelling carriage
2093 J. Blomfield, Colchester—Stands or tables
2094 M. Bebro, Manchester, and O. Hopwood and W. Elam, Liverpool—Printing tickets consecutively
2095 J. H. Banks, Knutsford—Buildings
2096 A. M. Clark, Chancery Lane—Breech-loading fire-arms.—A com.
2097 W. Daglish, Wellington Quay—Kilns for burning bricks, tiles, and pottery
2098 G. Alder, Newcastle-on-Tyne—Propelling vessels

1st July, 1868.

2099 R. Ward, Newcastle-on-Tyne—Twisting tobacco
2100 T. Ward and W. S Black, King's Lynn—Twisting tobacco
2101 W. Brookes, Chancery Lane—Rotary steam engines.—A com.
2102 W. Brookes, Chancery Lane—Electro-magnetic railway breaks.—A com.
2103 W. Brookes, Chancery Lane—Meters for measuring water.—A com.
2104 J. A. Smith, Little Russell Street—Photographic apparatus
2105 C. F. Crailsheim, Chancery Lane—Bottles for effervescing liquids.—A com.

2nd July, 1868.

2106 A. Taylor, Birmingham—Neckties
2107 A. Alexander, Belvidere—Carriages and locomotive engines for working on steep inclines
2108 L. Francis, New York—Printing purposes
2109 H. H. Henson, Westminster—Railway waggons and trucks
2110 W. Dean and R. Andrew, Derby—Stopping the loom upon the breaking of the weft thread
2111 J. D. Pinfold, Rugby—Making bricks and tiles
2112 J. E. Poynter, Glasgow, and T. L. Patterson, Greenock—Saltpetre
2113 E. J. Scott, Glasgow—Ornamenting boots and shoes
2114 F. A. Pavey, Bell Gardens—Marking board for billiards
2115 D. Hall, Winsford—Furnaces
2116 J. B. Gregson, Gateshead—Preparing lead to be used as a pigment
2117 E. Pavy, London Street—Preparing certain vegetable and animal fibres
2118 D. Fender, Berwick-upon-Tweed—Thrashing machines
2119 A. M. Clark, Chancery Lane—Barometers.—A com.
2120 A. M. Clark, Chancery Lane—Preparing flax.—A com.
2121 A. F. Robertson, Bedford Square—Carts.—A com.
2122 J. H. Johnson, Lincoln's Inn Fields—Shoes for horses.—A com.
2123 J. H. Johnson, Lincoln's Inn Fields—Bridges.—A com.

3rd July, 1868.

2124 C. Roussel, Louviers—Spinning
2125 A. Kane, Dundee—Tobacco pipes
2126 J. H. Johnson, Lincoln's Inn Fields—Paper pulp.—A com.
2127 G. Bennett and J. Woodcock, Manchester—Effecting communications between guards and engine drivers
2128 J. and G. M. Ward, Gorton—Locomotive engines
2129 J. B. Brown, Walker—Furnaces for calcining ores
2130 W. E. Newton, Chancery Lane—Automaton toys.—A com.
2131 M. Henry, Fleet Street—Receptacles for preserves.—A com.

4th July, 1868.

2132 J. A. Muller, Finsbury Square—Meter for regulating the flow of liquids
2133 J. Head, Middlesborough—Furnace grates
2134 A. Fryer, Manchester—Treating saccharine solutions
2135 A. Albini, Genoa—Mariners' compasses
2136 A. M'Neil, Tiverton, and W. Wheaton, Exeter—Salts of ammonia
2137 E. H. Newby, King William Street—Reducing aluminium from its ores
2138 R. Needham, Dukinfield—Fuel economizer
2139 T. G. Messenger, Loughborough—Erecting buildings
2140 A. M. Clark, Chancery Lane—Fastening for boots and shoes.—A com.
2141 G. Slater, Lamb's Passage—Folding machine

6th July, 1868.

2142 J. Kilner, Manchester, F. H. Oclee, Salford, and E. Burns, Manchester—Cork drawer
2143 P. Jensen, Briston—Sewing machines.—A com.
2144 A. Fryer, Manchester—Evaporating and concentrating purposes
2145 G. Davies, Lincoln's Inn—Locomotive engines
2146 E. H. Waldenstrom, Salford—Metallic rivets
2147 J. H. Whitehead, Saddleworth—Saddle pads

7th July, 1868.

2148 G. Davies, Lincoln's Inn—Dyeing.—A com.
2149 J. Thomson, Peckham—Chimney tops
2150 G. R. Wilson, Birmingham—Stereotype plates
2151 T. F. Mayall, Chancery Lane—India rubber soles for boots and shoes
2152 E. Coppée, Haine St. Pierre—Coke furnaces
2153 F. Veith, Manchester—Straps for driving machinery.—A com.
2154 J. Lawson and E. G. Fitton, Leeds—Machines for cleaning and spinning flax
2155 T. R. Crampton, Westminster—Constructing forts
2156 B. P. Walker, Wolverhampton—Effecting the junctions of driving bands
2157 A. P. Price, Lincoln's Inn Fields—Treating phosphates of lime.—A com.
2158 G. Morton, Birmingham—Ornamenting fire grates

8th July, 1868.

2159 T. J. Mayall, Chancery Lane—Gas tubing of india rubber
2160 T. J. Mayall, Chancery Lane—Electric telegraph cables
2161 C D. Abel, Chancery Lane—Ornamenting textile fabrics.—A com.
2162 J. Livchak, Vienna—Aeronautical apparatus
2163 J. F. Cooke, Cannon Street—Copying ink
2164 J. Holt, Upper Clapton, and G. S. Coponet, Clerkenwell—Printing machines
2165 J. Prest, W. Mather, and W. Doherty, Bedford Leigh—Chaff cutters
2166 W. Brookes, Chancery Lane—Evaporating and condensing liquids.—A com.
2167 A. J. Le Blanc, Paris—Belts for driving machinery
2168 E. Coppée, Haine St. Pierre—Crushing and washing coal
2169 T. Kerr, Paisley—Fire-arms
2170 W. Tasker the younger, Andover—Elevating straw

9th July, 1868.

2171 E. Rouget, Paris—Fixing on paper drawings in crayon
2172 M. Bebro, Manchester—Containing and delivering tickets
2173 W. Hadfield, Ardwick—Looms for weaving
2174 J. Chandler, Mile End Road—Drawing and preventing waste of water
2175 T. J. Mayall, Budge Row—Treating india rubber
2176 W. Creasy, Bedfield—Drying grain
2177 J. Harris, Harefield Ironworks, and V. Pendred, Dulwich—Wrought iron and steel
2178 J. Mabson—Propelling persons in the water
2179 H. H. Doty, Bury Street—Lamps for signalling at sea
2180 T. Nuttall, Bury—Bearing surfaces of horse collars
2181 W. R. Oswald, Sunderland—Formation of steam and water joints
2182 T. Worth, Rochdale—Railways and railway engines
2183 A. M. Clark, Chancery Lane—Looms.—A com.
2184 J. H. Johnson, Lincoln's Inn Fields—Orphonium.—A com.

10th July, 1868.

2185 W. L. G. Wright, Glasgow—Rotatory engines
2186 E. T. Hughes, Chancery Lane—Wooden pavement.—A com.
2187 C. E. Brooman, Chancery Lane—Utilizing old railway rails.—A com.
2188 G. Davies, Lincoln's Inn—Filling the spaces between the beams of iron floors
2189 J. Jefferys, Tottenham Court Road—Studs and buttons
2190 J. D. Churchill, Oxford Street—Hot air engines
2191 F. R. A. Glover, Brading—Fishing ships' anchors

11th July, 1868.

2192 G. Davies, Lincoln's Inn—Armour for the protection of vessels of war.—A com.
2193 W. Russell, Chiswell Street—Paper bags and envelopes
2194 T. Travis, W. H. Prince, and J. Tomlinson—Finishing yarn and thread
2195 J. S. Nibbs, Birmingham—Portable engines
2196 T. King, Spitalfields—Bungs for casks
2197 R. Mackie, Stewarton—Caps or bonnets
2198 J. D. Brunton, Kentish Town—Tools for cutting slate
2199 C. E. Brooman, Fleet Street—Locks.—A com.
2200 H. Garside, Manchester—File-cutting machines

13th July, 1868.

2201 E. Edwards, Baker Street—Photography
2202 J. N. Willis the younger, and S. Judd the younger, Gravesend—A new syringe to be used in combination with combs.
2203 W. J. Hanson, Cleckheaton—Dyeing wool
2204 G. B. Puricelli, Bedford Square—Printing
2205 A. Oldham, Southport—Adjusting picture frames
2206 A. Munro, Arbroath, and W. B. Adamson, Glasgow—Tools
2207 A. Munro, Arbroath, and W. B. Adamson, Glasgow—Iron
2208 G. R. Mather, Wellingborough—Mixing colours
2209 G., G. W., and J. Betjemann, Pentonville Road—Book slides
2210 W. R. Lake, Chancery Lane—Permanent way of railways.—A com.
2211 W. R. Lake, Chancery Lane—Railway carriages.—A com.

14th July, 1868.

2212 J. C. Leaver, Upper Thames Street—Railway sleepers
2213 J. and J. M. H. Taylor, Birkenhead—Propelling ships
2214 J. Bastow, Shepherd's Bush—Bleaching textile fabrics
2215 E. F. Kittoe, Stratford—Fish slices for turning over fish
2216 J. Booth, Kingston-upon-Hull—Mills for grinding bones
2217 J. Cope, Finsbury, and J. Bradbrook, Dalston—Bookbinding
2218 T. Wood, Manchester—Railway carriages
2219 W. Shaw, Clayton—Looms
2220 W. B. Farwell, Frankfort-on-the-Maine—Heating railway carriages by steam
2221 C. J. Galloway and C. H. Holt, Manchester—Operating piston valves of steam engines
2222 W. Payton, Victoria Park—Breech-loading fire-arms
2223 J. Thompson, Aldersgate Street, and J. G. Ingram, Hoxton—Caps for feeding bottles
2224 L. Hannart and N. A. Aubertin, Cheapside—Door plates
2225 L. Hannart and N. A. Aubertin, Cheapside—Printers' type
2226 H. Lawrence, Durham—Moving furnace bars

15th July, 1868.

2227 A. Taylor, Birmingham—Spring studs
2228 C. de Bergue and J. C. Haddan, Westminster—Safes
2229 W. Hollingworth and H. Halstead, Bradford—Regulating the amount of gas supplied to street lamps
2230 R. Conty and J. Richard, Paris—Instrument for facilitating vocal instruction at schools
2231 R. Chamberlain, Eaton Square—Tool for mortising machines.—A com.
2232 J. H. Johnson, Lincoln's Inn Fields—Lamps.—A com.
2233 J. Bonnall, Grantham—Drills for distributing corn
2234 T. Cook, Old Kent Road—Presses for expression of oil
2235 W. Turner, Blackburn—Buckets

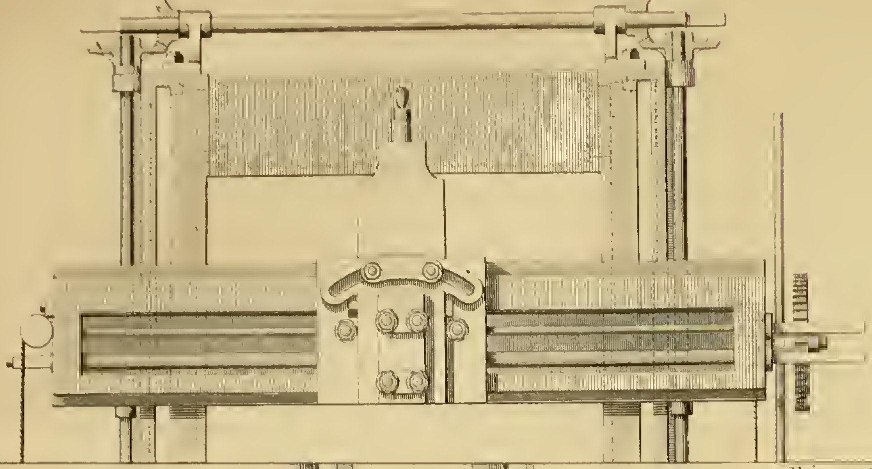
16th July, 1868.

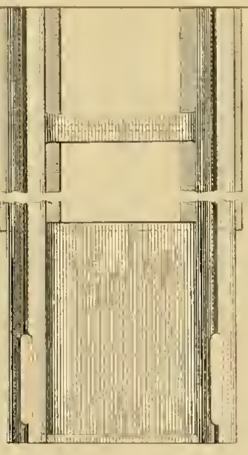
2236 J. L. Macfarlane, Upper Holloway—Shirt fronts
2237 R. Whiston, Wolverhampton—Safety window
2238 H. W. Ripley and T. Shackleton, Bradford—Winding warps of cotton
2239 R. Berson, Edgeware Road—A universal rapid self-boiler by means of charcoal fire
2240 T. F. G. Wintour, Carlton Road—Ventilating
2241 D. Russell, Camberwell—Masting of ships
2242 J. C. Ramsden, Bradford—Looms
2243 W. R. Lake, Chancery Lane—Implement for cutting hay.—A com.
2244 W. R. Lake, Chancery Lane—Links or couplings for harness.—A com.
2245 S. Davis, Strand—Clipping the hair of horses

AMERICAN PLANING MACHINE.

WILLIAM SELLERS & COMPANY,
Engineers,
PHILADELPHIA, U. S. A.

Fig. 1.





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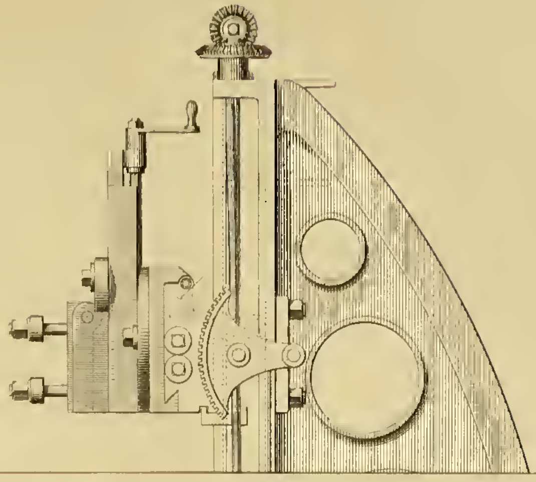

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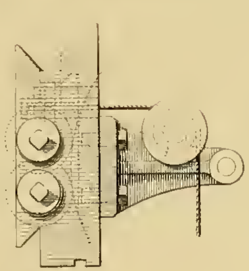

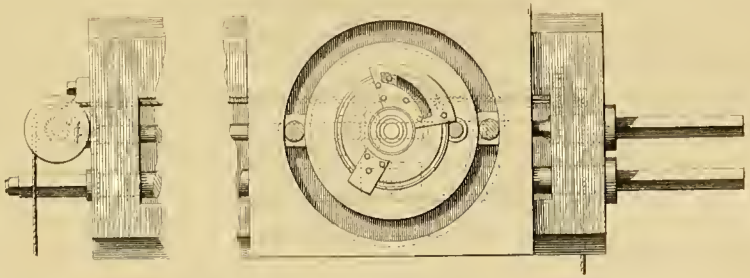

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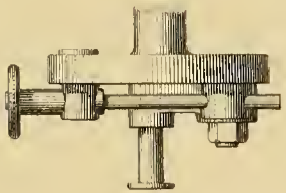

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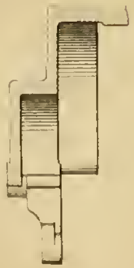

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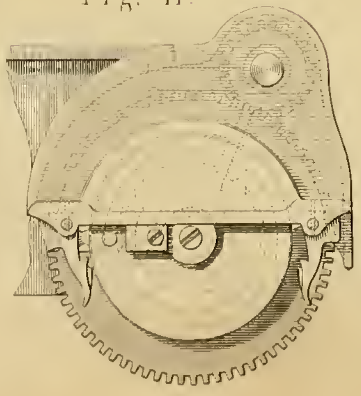

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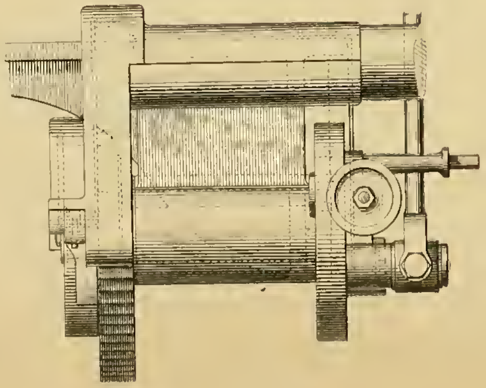

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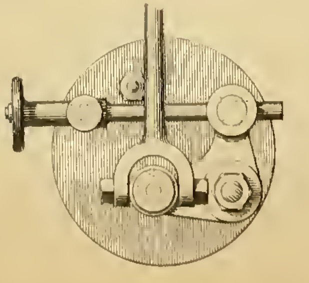

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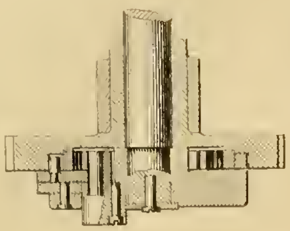
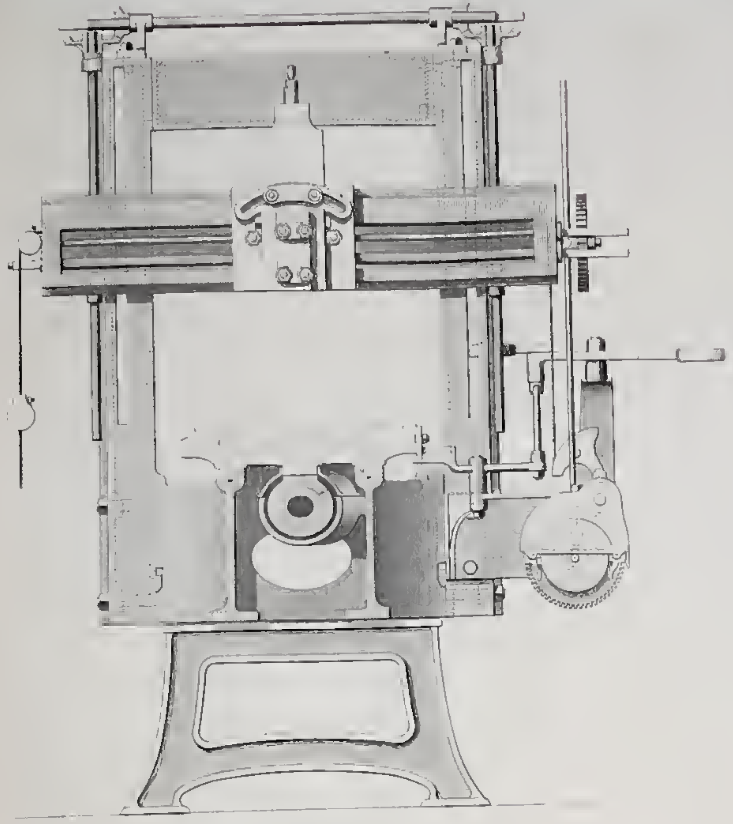


Patent Offices 47 Lincolns Inn Fields London and 166 Buchanan St Glasgow

AMERICAN PLANING MACHINE.

WILLIAM SELLERS & COMPANY.
Engineers,
PHILADELPHIA. U. S. A

Fig 1



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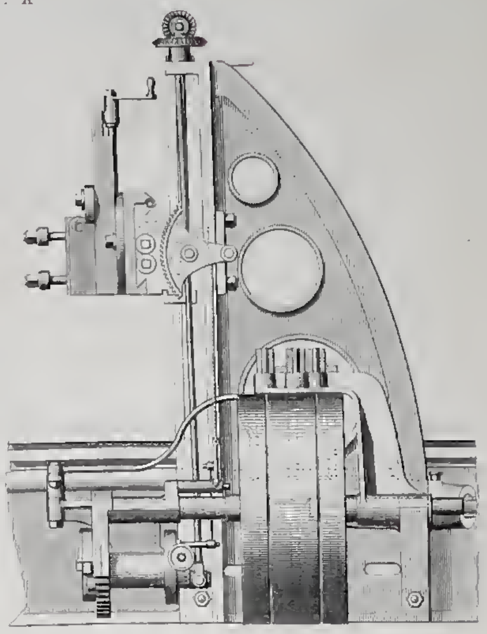

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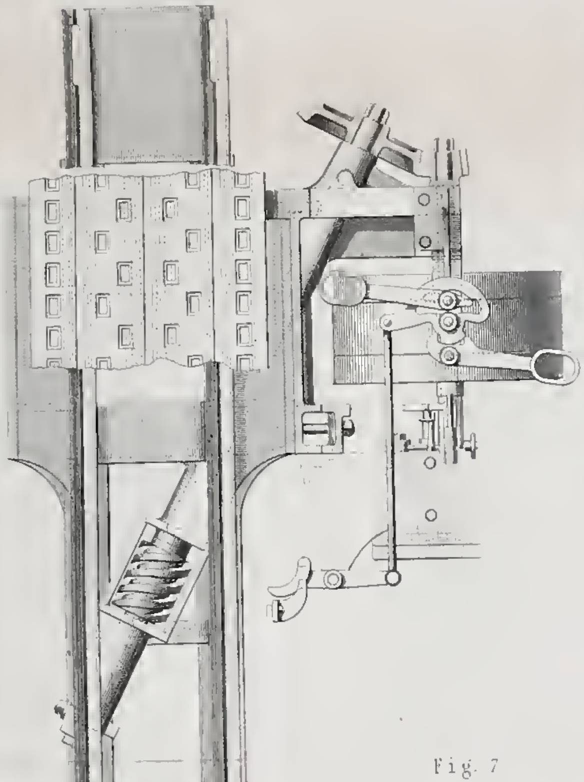
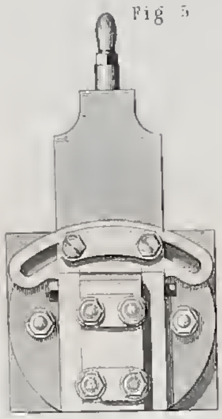


Fig 5



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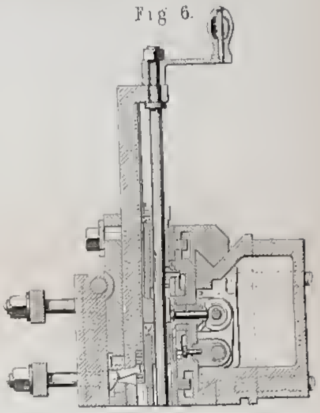

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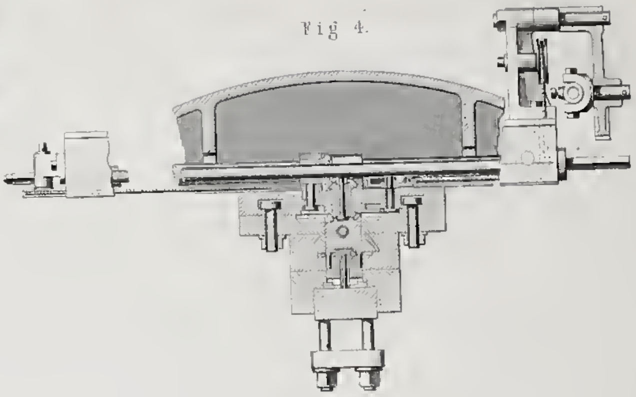

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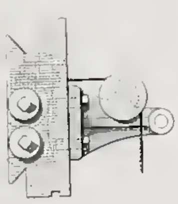

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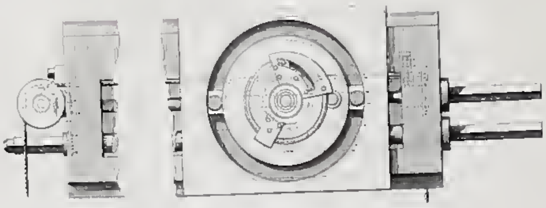


Fig 12

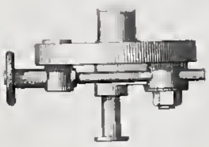
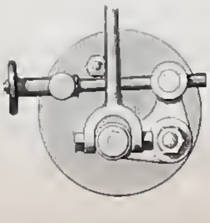


Fig. 13.



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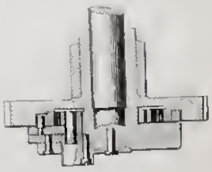

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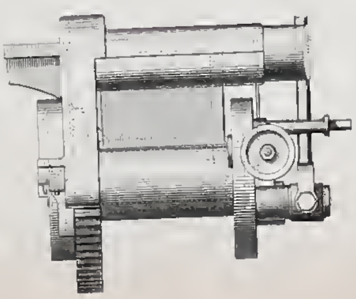


Fig 10

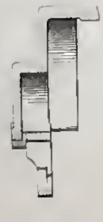
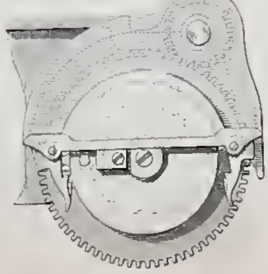


Fig. 11



Patent Offices 47 Lincolns Inn Fields London and 166 Buchanan S.t Glasgow

BOILER-PLATE BALLOON BUILDING.

Why not? We have iron shipbuilding, and why not iron balloon building? No reason not, except, perhaps, that the idea of a boiler-plate balloon is rather a new one. But let us begin at the right end; our title rather led us by the nose.

One-idea'd men are commonly, and perhaps not wholly unjustly, thought by the common herd to own respectively "bees in their bannets;" total abstainers, vegetarians, homœopathists, cranioscopists, spiritualists, and so forth, do not commonly command the confidence of safe men on change, nor of men of letters or science either.

But yet, whether we ought or ought not to distrust the one-idea'd man depends, or should depend, very much upon what his great solitary idea may happen to be. Now and again the one-idea'd man is the great reformer, the revealer of new truths to his fellow-men, the revolutionist of what is esteemed as old and venerable and sacred, but yet which is really rotten and to pass away; and such men are generally rewarded by their fellows with persecution and martyrdom.

Amongst those people who *are* more or less mad, or whose too much wisdom seems to make them mad to the ignoble mass around them, are those whose whole soul is engrossed with the one notion of flying in the air. A very old notion, but which comes up as fresh as ever every few years, and was never fresher than just now, when we have an Aeronautic Society in London, with dukes (addicted to attending fires in brass helmets), and even sedate and sensible LL.D.s, like Dr. Fairbairn, upon its council or numbered amongst its members. Now, with all due respect for those who have hazarded their names in connection with this society, the doings of which have been the wonder of the children, old and young, at the Crystal Palace of late, we cannot avoid ventilating our own secret notion, that if there be one subject more than another which may be taken to indicate a decided "craze" in any man's cranium, it is his ardent devotion, entire belief, and steadfast application of the energies of life, to the solution of the problem of flying in the air. Not that the thing itself is absolutely impossible and provably so, like getting to the sun or to Arcturus, nor yet that, if done, the achievement must turn out useless and unprofitable; but rather, for two wholly diverse reasons, which are—first, that this is not, just yet at least, the thing that "our hand finds to do;" secondly, but principally, that those who deal with this balloon and flying question do manifest generally the most feeble, inane, incapable conceptions of what it is they would be at, and treat of it in a way that, when it does not make any one who is but a little acquainted with the *methodus tractandi* in dynamic and such like inquiries, laugh at them, makes the lip tend to curl in scorn at their silliness—silliness both in the choice of a subject to butt their energies against, and silliness in the way they attempt to butt at it, much like the incompetent and ridiculous efforts of a young bull calf before his butting horns have sprouted. Yet with all this, aeronautics, as ballooning and flying have been magnificently termed, though nobody as yet has ever navigated the air upon a voyage of even 500 yards long, have, like every other subject of human thought, their sober and sensible side, as well as their fools' paradise and ridiculous one.

The practicability of rising into the air, and moving in any direction therein at will, is after all a mixed question of dynamics, pneumatics, and practical mechanics; and whatever may be its future fate, all real chance of its solution, negatively or positively, depends upon its being approached through these portals, to the entire disendowment of the whole of that faculty of ingenious men who invent wonderful wings and air oars, and paddle wheels to beat the middle air, and rudders to steer by in that liquid of less than $\frac{1}{800}$ the density of water, without, in the least degree, inquiring beforehand what may be the relations of the forces and resistances they expect to call into play.

The power to take the wings of the dove and fly away is a notion that fascinates the fancy, but it is not easy to see that any great or very valuable results must follow from its attainment; nothing, in fact, in the least resembling the results which steam travel by sea and on land have conferred upon us. That very long trajects or "voyages," as Mr. Coxwell would probably prefer to call them, could be made and at a very fast rate, if we only had the power to determine the direction in which we would go, and were not at the mercy of the wind to go straight before it, whether it blew north at one level, or south at a different one, has been already proved; Mr. Green's Nassau balloon of 60 feet high and 50 feet diameter, which held 85,000 cubic feet of light coal gas, in November, 1836, having gone in a few hours from Vauxhall, London, to Weilburg, in Nassau, with three or four passengers.

Vertically, probably no balloon has ever ascended higher than the summits of a few of the highest mountain peaks of our planet are elevated above the sea level. Much popular excitement has been latterly raised in England, by the vigorous use of the newspapers, on the subject of the supposed accessions to meteorological science through the frequent balloonings of Mr. Glaisher and Mr Coxwell. We apprehend the real results of any value are exceedingly small, and that in fact nothing further or more valuable is possible from ascents limited to a few hours and to some 25,000 feet in altitude. If anything is really to accrue to science from this method of experimenting, it will be by *large empty captive balloons*, carrying up nothing but their own weight and certain instruments, which shall be in constant electro-telegraphic and self-registering communication with the earth, the conducting wires being in the restraining rope. Such balloons might *possibly* be caused to ascend and remain for some days at an altitude of *ten miles* above the earth, and there can be little doubt might afford some physical and meteorological results of great interest and value. The funds of the British Association would be more worthily thus employed, than in expeditions with little result, except the occasion for a show of claptrap and scientific intrepidity.

No balloon, it may be safely affirmed, has ever yet been caused to move *against* even the summer breeze in which it floated, nor to move laterally in any direction other than that in which it may have been helplessly driven along by the wind, by any forces acting from the car of the balloon upon the air around.

Wings, air-oars, rudders, vanes, &c., to act on the air by the power of one or two, or even ten or one hundred men's arms, from a balloon car, are utter folly. The notion is as crude and as old as the very beginnings of ballooning, if indeed not as old as Dædalus and Greek mythology. Archytas and his artificial pigeon, which it was alleged could fly, has been again and again referred to as an example of Greek volitation; but it seems improbable that the Greek notions ever were carried into practice, or went beyond those of poetic myth, like the carrying off of Ganymede by the eagle of the Olympian Zeus. The middle ages, in the idleness of churchmen's brains and the darkness of the times, bred the most extraordinary and amusingly absurd notions as to sailing or flying through the air by various means. An Augustinian monk, Albert of Saxony, dilated in the fourteenth century upon the possibilities of aerial sailing, and indeed seems to have been the first to do so since the days of classic fable. Francesco Mendoza, a Portuguese Jesuit, in 1628, and Caspar Schott, in Germany, take it up with the so-called science of their day. The most amusing sample of this, however, is that of Father Lanzerus, who gravely assures us that an egg shell filled with morning dew, placed at the foot of a ladder at dawn, will mount, round by round, as the day advances, and finally reach the top. De Bergerac seems to have entertained the same wild fancies as to the lævitant powers of "morning dew;" indeed be hints that human flight had been attained by its means. This was flying by "occult properties," however, not by wings. Blanchard, one of the first of French aeronauts, Guyton de Morveau, and Bertrand, at Dijon, tried those oars and wings in 1784. Cayley, Partridge, and Eubriot, with Polli of Milan, projected various devices of fish-shaped and elongated-bellied balloons, and sails or oars, or vanes, in 1837 to 1840, which were tried in 1839 at Paris, and found nugatory. Graham, one of our most experienced balloon men, tried these once more in 1852, and again in 1856, without any good result.

These were all cases (and scores more might be referred to) in which gravity was overcome by the statical ascensive power of an attached balloon. Henson's flying machine, which made so much *preliminary* noise in London about 1842, with a wing platform of some 100 feet spread, and an artificial tail of some 50 feet long, belongs to the more ambitious but still more absurd class of flying machines, in which the prime mover is called upon not only to overcome the entire resistance of the air to motion, but to overcome the entire force of gravitation also. Perhaps the *ne plus ultra* of these follies may be found in the solemn but amusing proposals of Doctor Lotzsky, in 1846, whose ἑυρηκα consisted in "attaching a considerable number of small balloons (like the blue and yellow bubbles hawked about for children's toys) in suitable positions, along with wings, to the body of a slim youth," who would then find no difficulty in his aerial way; or in those of Lord

Carlingford, whose "Archedon"—a sort of megatherium of the air, like the dragons that the enchanters of our childhood were borne upon—his lordship indignantly complained had attracted no attention when exhibited by him in 1865 at Dublin.

It may be affirmed without much fear of contradiction, that no human being, by the muscular power of his arms or lower limbs, acting through wings upon the air, has ever raised himself from the earth's surface, and flown fifty yards. A man dropping from a height, or any heavy body, such as a weighted balloon or parachute, dropping along with an inclined surface attached—an oblique parachute in fact—is another case altogether, one in which the resolved energy of descent due to gravity may produce a considerable amount of lateral motion. The practicability of this was proved, in fact, by Mademoiselle Garnerin, who wagered that she would cause her parachute, let go when over a given point, to reach the earth at a certain other and horizontally distant point, which was named beforehand. She actually did alight upon the earth within a few yards, it is said, of the point fixed upon. This has, amongst other projects, formed one of those for balloon guidance—namely, that the balloon should ascend with the reactive inclined surface sloping in one direction, and having got as great an altitude as was convenient, the inclined surface should then be sloped the reverse way and a partial descent be made, by which lateral transfer in the same direction as before might be produced, and thus, by such alternate ascents and descents in diagonal lines, or "tacking" in a vertical plane, a determinate horizontal transfer be secured. But this leaves out of view that the resolved force in ascending is so much deducted from the carrying power of the balloon, as is also the gas wasted for each partial descent; and that, what might be mechanically true in still air, would not necessarily prove so in even a mild breeze; and that such breezes or winds may blow in different directions at different altitudes. The entire conception of steering balloons by means either of movable sails or of rudders, rests upon the fallacious analogy of omitting to consider that the ship is not *in* the water, but on its surface; that the water affords a fulcrum for the resolution of forces due to the air, altogether irrespective of the latter, and wanting wholly to the balloon.

This is the purely mechanical aspect of the matter, as related to the balloon itself. The idea of coercing its movements by the animal power of a man or men in the car, like the notion of flying direct, involves complete inadequacy of conception as to the nature and amount of muscular force conferred upon birds (from which the analogies are assumed to be derived), and employed by them in vibrating their wings when flying. Borelli, the celebrated originator of animal mechanics as a science, in his work *De Motu Animalium*, in 1670, demonstrated in a very clear way the enormous muscular power conferred upon birds for the purpose of flight, and showed the inadequacy of the muscles of human limbs to move wings—directly, at least. Any one who will look at the body of a dead bird deprived of its feathers, will see that a bird is not much more than a flying machine. Take a pigeon, for example. The great pectoral muscles weigh probably as much as the whole of the rest of the muscular system of the animal, or we may say, about a third of its total weight, and are specially arranged in the best way for producing action upon the pulsating wings, as almost their sole purpose. The arms of a man of mean weight probably do not weigh more than about $\frac{1}{5}$ or $\frac{1}{6}$ of his total weight, and their muscles being designed to fulfil all those varied and important and wonderful movements which Bell, in his work upon "The Human Hand," has so beautifully developed, are arranged with a complexity which does not admit of nearly their whole force being employed to the best advantage in a single direction, and that, one causing vibration of the arms at the shoulder-joints.

The Condor is the largest bird upon the earth known to man which possesses any considerable power of flight. The spread of its wings is about the same as that of a man's arms and hands; but the Condor's body probably does not weigh one-eighth that of a man of mean weight, and the biggest birds of which we have any traces in creation, the extinct Dinornis family of Madagascar and New Zealand, are not flying animals at all, but like the ostrich, fast runners.

The power of flight of birds, too, *against the wind* is far more limited than ordinary observers are aware of, although the mechanical effort measured into foot pounds which some are capable of putting forth is amazing. A pigeon, for example, has been known to transport its own weight, against some little wind, for half an hour, at a rate equal to nearly 90 miles per hour, it is stated. The common English rook is a bird of long-enduring and powerful flight, as all must know who have witnessed the beautiful and poetic spectacle of the endless aerial procession of the tenants of some great old rookery returning to rest, high aloft through the clear sky of an autumn evening. Now, any one who has closely watched the movements of rooks flying upon a gusty, blowing day—say about the autumnal equinox, when they are much abroad—may have remarked that, at a certain and not very high velocity of wind, these birds are no longer able to contend with it. When caught on the wing by a powerful gust, they let themselves quietly drop to leeward, and then, when the lull comes, make again their voyage against the wind by a continual succession of doubles, or tacks, which are oftener made in vertical than in horizontal planes.

Thus, the rook's limit of power in forcing himself directly against the wind—or, rather, his power even to hold his place against its current—is found at a velocity of probably 30 to 35 miles per hour, or about 44 to 51 feet per second. Such a wind occurs continually in our own climate, and its pressure would not be competent to sustain 1 inch of the water gauge.

If, then, the limit of flying power be so soon reached in the case of comparatively small and very powerful birds, we readily may see why the power can never be reached by man at all, by direct muscular effort; and if not reached by one, it can as little be reached by the efforts of one hundred men, combined. For a short spurt, as in rowing a boat race, Professor Haughton has shown that a man may be able to put forth about *six times* as much work as he could do if employed in day labour for 10 hours a day. That is to say, he can put forth work at the rate of about 4 foot tons per minute; or, taking a man's weight as $\frac{1}{15}$ of a ton, he could for a short time (if he could do so by rowing), raise his own weight at the rate of 60 feet per minute, or of 1 foot per second. But in rowing, thighs, legs, arms, loins, chest, nearly all the muscles of the body, are brought into effective co-operation. In flying, only those of the arms, or possibly in some minor degree, those of the legs and thighs, as in swimming, could be conceived brought into play; so that even the above greatly overrates what a man could do in flying. Robertson Buchanan ascertained experimentally that the ratio of work given forth in rowing was to that in pumping (standing) as 248 : 100. Now the latter movement comes much nearer to flying than rowing does, so that we may not be very widely astray in concluding that a man, *could he fly at all*, could not do more than raise his own weight at the rate of about 4·8 inches per second for a short spurt; or, if flying for 10 hours, at $\frac{4{\cdot}8}{6} = 0{\cdot}8$ of an inch per second—a truly conservative pace, safe to break no bones, and at which it would take him a good while to reach that upper air, if not the stars, which we may suppose to be the *Ultima Thule* of every good aeronaut.

We judge this so, by the title of one of the most remarkable books which we have ever met on this subject, one of which scarcely anything seems generally known, though it was published in London in all the panoply of royal quarto, with really magnificent, interesting, curious, and artistic engravings and illustrations, by Chapman & Hall, no longer ago than 1865. We refer to "ASTRA CASTRA, Experiments and Adventures in the Atmosphere, by HATTON TURNOR, Esq., of the Prince Consort's Own Rifle Brigade."

The work, though overladen with a profusion of sometimes amusing, sometimes dull irrelevant or but constrainedly relevant matter, is yet the fullest, best, and completest record of the whole career of flying and ballooning that exists, to our knowledge, in any language. We say this with full knowledge of the work of General Meusnieres, published in 1785, which was almost unnoticed until M. Marey Monge, in his "*Etudes sur l'Aerostation*," published in 1847, brought it into notice, by being largely indebted to it; and also of Mr. Monk Mason's work, the only precedent work of a general character in English.

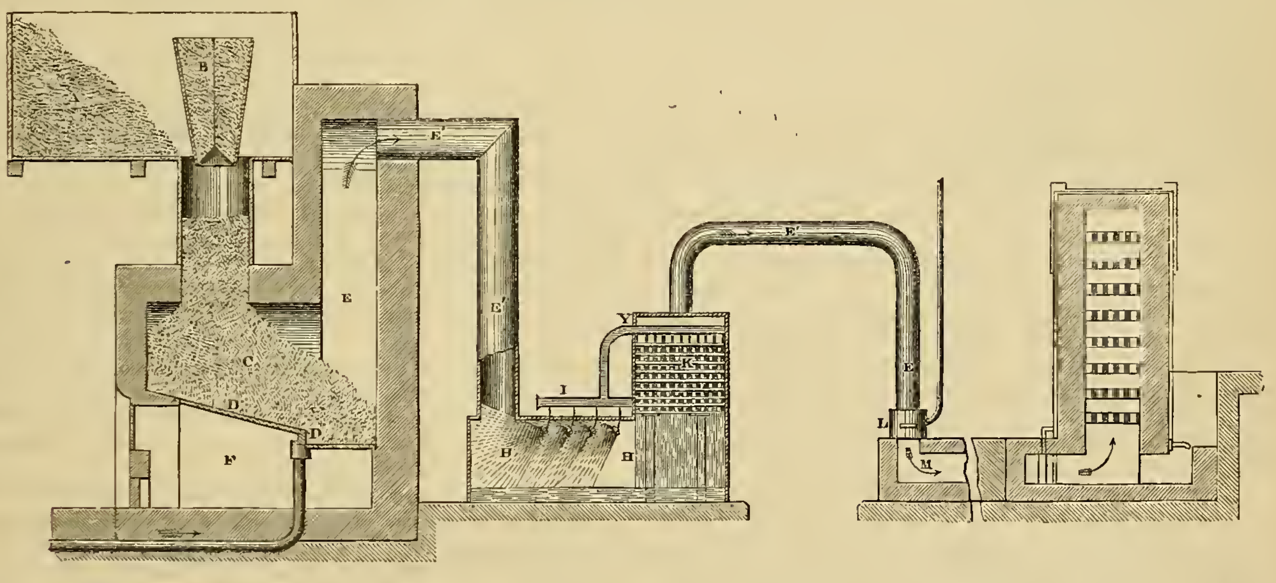
Mr. Turnor's work is plainly that of a painstaking reader and writer, and of a scholarly gentleman, and, unless we widely misjudge him, of a good and truthful man, and higher individual praise cannot be bestowed. Yet, if a proof were needed that a certain craze attaches to all aeronauts, this volume might assuredly be adduced in illustration. After expending hundreds of pages in historical record of what has been suggested, attempted, and done in ballooning and flying, and given a whole chapter to the science of the subject, in a rational and on the whole correct way, though apparently without the power to use symbols or apply analysis, what think ye the author ends with, a appendix "on the substance of things hoped for, the evidence of things unseen." From air to spirit—from balloons and wings to angels, principalities, and powers—there is but one step; the end of ballooning is, how and in what sort of another world are we to find ourselves, and how are we to get there! To answer this pneumatics are insufficient, and so Mr. Turnor calls in theology, and treats us to a most extraordinary commentary upon Christianity, revelation, the Bible, and our hopes and fears of the future, in this most extraordinary appendix; turning over the leaves of which, in connection with what has gone before, we are unable to repress the thought—"Mad, mad as a March hare:" and yet it would pain us much to offend the writer of this strange stuff, meant as an integral part of a work, the other parts of which show great research, information, and refinement of taste.

(*To be continued.*)

THE SWEDISH REHEATING FURNACE, WITH GAS FROM SAWDUST AS FUEL.

THE producer and regenerative furnace of Siemens has recently been adapted by M. F. Lundin, of Carlstad and Munkfors, in Sweden, for the production and utilization of gas from sawdust; and as this application has been found to effect great economy in the manufacture of iron, we deem it important to draw attention thereto, for in many other countries where iron abounds but coal is scarce (such as Canada), there can be no question but that the Swedish adaptation points with much weight. These furnaces are arranged to produce gas arising from any combustible materials, but the remarkable economy resulting from M. Lundin's application is due to the low value of sawdust in Sweden, which at the great sawmills is charged for at the rate of 8000 francs (equal to about £330) a year for the quantity produced per saw. Fig. 1 of the engravings represents the distillatory apparatus for producing gas from sawdust; and an elevation of the regenerative apparatus, while fig. 2 is a plan. At A, fig. 1, is shown the sawdust receptacle, the material being charged by a workman into a funnel, B, the lower end of which is closed by a drop cone, which is connected to a counterpoised lever in order that it may be lowered when the sawdust is charged, and thereafter when raised constituting a close joint with the funnel bottom. This is placed as shown at C, fig. 1, immediately below the charging funnel, B. This chamber, which is vaulted or arched, is separated from the hearth, F, by cast-iron plates, the first or higher ones, D, being inclined, thus causing the sawdust to fall towards the horizontal plate, D′, situated below the gas conduit, E. These plates are at present formed so that the air which enters by the conduit, G, not only serves for the combustion of the sawdust which falls upon the hearth (which is shut or closed), but again penetrating the distillatory chamber raises the temperature of the sawdust and consequently facilitates the distillation. The gas extracted directs itself into the conduit, E; it cannot escape through the drop cone on account of the great thickness of sawdust which fills up the passage situated below the funnel of the chamber, C. In the conduit, E, the temperature of the gas ranges from 400° to 420°. By means of the pipe, E E′, the gas is led towards the condenser, H. In this travel it loses about 50° of temperature, so that it arrives at the condenser at about 350°. Above the condenser, H, a pipe, I, is situated, provided with eight smaller pipes of 4 to 5 millimetres in diameter, which enter into the condenser. The water which arrives by these tubes is projected on all sides through copper roses. The gas passes accordingly in thin layers between spaces formed by iron bars, whose weight is 1700 kilogrammes or thereabouts, disposed in transverse planes at K. For the purpose of keeping these bars constantly cold the pipe, *g g*, which turns in different directions, is perforated with a large number of holes through which the water escapes and sprinkles them. Lastly, a conduit, E″ E″, leads the condensed gas towards the furnace.

Fig. 1.



The sawdust employed is partly of green timber, and contains about 45 per cent. of moisture, the gas distilled in the pipe containing 35 per cent.; after the condensation the quantity of water is reduced to 2 in 100 parts of gas by weight, or 3 in 100 of volume. The consumption of water for cooling is 70 litres per minute; its temperature after the condensation has been effected is augmented about 30°. This quantity of water serves for a single regenerative furnace, but if a preparatory furnace is at the same time used the quantity must be doubled.

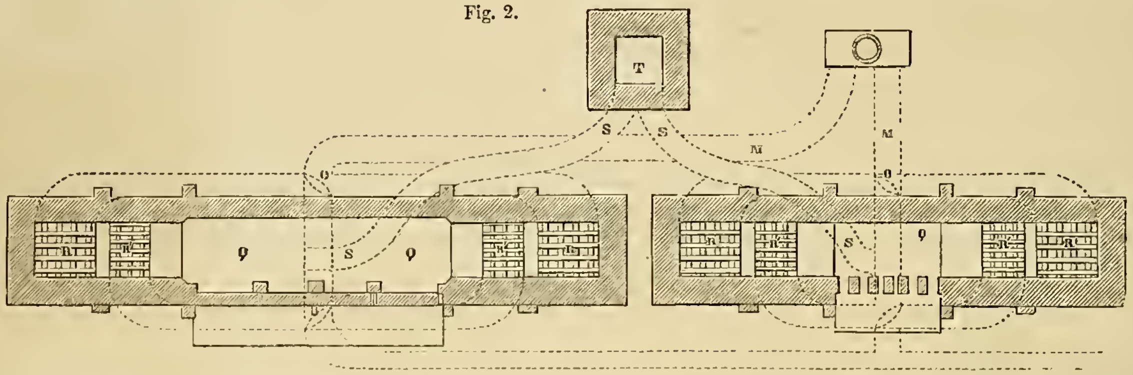
The composition of the gas expressed in volume and weight by M. Lundin is as follows:—

Composition.	Volumes.	Weight.
Carbonic acid, ...	11·8	19·6
Carbonic oxide, ...	19·8	20·8
Hydrogen, ...	11·3	0·87
Marsh gas, ...	4·0	2·4
Nitrogen, ...	53·1	56·3
	100·0	99·97

The composition is the same before as after condensation. The very great quantity of carbonic acid is carried off by means of hydrated lime mixed with the water in the condenser. We have above stated that the sawdust used in these furnaces in Sweden contains about 45 per cent. of moisture; if the sawdust was all new it would contain from 50 per cent. to 60 per cent., which high proportion is reduced either by mixing with it a portion of dried sawdust or some pieces of wood. The gas circulates in the pipes or conduits at the low pressure due to a column of 3 millimetres of water. And as one of the products of the distillation, there is obtained about 164 litres of wood tar per week. The pipe, E, conducts the gas into a box, L, containing two valves, one of which allows the gas to pass into the conduit, M, which leads it to the furnace, and the other communicates by a pipe, N, by which the excess of gas escapes into a gas-holder.

The plan, fig. 2, represents two furnaces—the one for re-heating, the other as an auxiliary or preparatory furnace for primarily heating the charge. Both are composed of two similar parts, which together constitute two furnaces, united and operating alternately. From the valve-box two conduits, M, proceed, which lead to the boxes, O, situated at the central part of the two furnaces, between the two hearths, Q, opposite to which two other boxes, O′, are situated, connected by a pipe with a blast-producer. From each of the boxes, O and O′, other conduits proceed, which conduct the gas and air to the corresponding regenerators, situated at each end of the furnace. The gas regenerators, R R, are situated at the extreme part of the furnace, and those for the air, R′ R′, near the sides of the hearth. The boxes, O and O′, contain a valve or cock, which, by being turned in one of two directions, leads the gas and air towards one or the other of the furnaces. Between the furnaces a conduit is placed, which leads the smoke and other products of combustion to the chimney, T.

Fig. 2.



The cost of a furnace of the foregoing construction is about 8600 francs, and on 1700 tons[*] of 1000 kilogrammes produced a year, an economy of at least 8760 francs is effected, and that by employing a Siemens' condenser and regenerator, just as is used for gas extracted from wood, charcoal, or other fuel. The necessity for repairing the furnaces is found to be very rare when even very elevated temperatures are employed. Through a six-aperture furnace about 487 kilogrammes a week can be produced, by means of four hammers, the weight of each being 400 kilogrammes. The iron made at Uddeholm, where the first furnace of this species was constructed, in October, 1865, is always reheated to a very high temperature. Each 100 kilogrammes requires about 400 litres of sawdust, containing at least 8·50 kilogrammes of carbon, 8·50 of hydrogen and oxygen, and 14 kilogrammes of water, when the sawdust comes direct from water-borne timber. The loss appears less than usual, this no doubt resulting from the excessive heat, and consequently greater rapidity with which the iron is drawn out. It should be explained that in Sweden the iron is *hammered* into bars and plates, and not *rolled*, as in this country and elsewhere—hence the term "drawn out." The first heating, made with coal in the old gas furnace, necessitates the consumption of a hectolitre and a half of coal for each 100 kilogrammes of iron in bars. The auxiliary furnace has been served since January, 1860, by means of the same generators and condensers which supply the reheating furnace. Actually 0·60 metres to 0·80 metres of sawdust are consumed for the preparatory heating and final reheating of 100 kilogrammes of iron in the bar. In the furnaces provided with gas from charcoal 0·30 to 0·38 cubic metres of charcoal are employed; therefore in this last case the real quantity of carbon to 100 kilogrammes of iron is from 90 to 100 kilogrammes, and more, having regard to the loss caused or due to the heat taken up in desiccating the wood.

The gas which passes from the furnace into the chimney is of a temperature of about 300°, containing at least 7 per cent. of aqueous vapour. Good dry wood charcoal, which contains 8 per cent. of water, produces in generators constructed on Ekman's system a gas of 1394° temperature, and in the furnace a temperature of 2666°, the combustion being effected with air at the ordinary atmospheric temperature; but if the temperature of the air is raised to 100°, the temperature, instead of being as above stated, becomes 1473° and 2757° respectively. On the contrary, the gas from wood charcoal contains but 1 per cent. of aqueous vapour. The gas produced from desiccated wood contains more water than that led through Lundin's condenser. The durability of the furnace is notable, and said to be due to the absence of cinder. During eight weeks the thickness of the roof (10 centimetres) has only diminished from 6 to 9 millimetres, and the walls appear equally undestroyed. The bricks composing the two or three upper layers of the regenerators attached to the furnace for the final reheating ordinarily are renewed in from four to six weeks, whilst the regenerators for the preparatory furnace last much longer.

Such are the results with Siemens' regenerative system, that any kind of fuel can be employed.

TABLE SHOWING THE RESULTS OBTAINED AT MUNKFORS DURING 1866 BY MANUFACTURING IRON WITH GAS FROM SAWDUST, COMPARED WITH RESULTS OBTAINED WITH CHARCOAL FURNACES OF THE SOCIETY OF UDDEHOLM.

Year of Experiment, 1866.	Time in Days and Hours, 24 hours being taken as a day.		Puddle Balls.	Scrap Iron used in Tons.	Iron drawn into Bars, Tons.	Loss per cent.	Consumption per 100 Kilogrammes.				Maxim. weight of iron drawn out per week from a single furnace in tons.
							Cubic Metres of Sawdust.	Cubic Metres of Charcoal.	Wood Charcoal not burnt Kilog.	Time in Hours.	
	Days.	Hours.	Kilogrammes.								
Furnace working with sawdust at Munkfors, ...	206	11	1859·96	104·99	1532·30	11·17	0·776	?	38	0·31	57·59
Two furnaces working with charcoal at Munkfors, ...	47	2	325·62	18·20	269·94	12·19	?	0·376	97	0·85	20·64
Total, . . .	253	13	2165·58	123·19	1802·24						
Charcoal furnace at Stjernfors, . .	263	8	1024·08	54·12	885·90	12·18	?	0·446	115	0·75	23·20
Charcoal furnace at Gustafsfors, . .	284	4	1076·77	46·68	893·53	13·26	?	0·477	123	0·75	22·22
From preceding year.											
Charcoal furnace at Munkfors, . .	274	21	1067·72	54 35	889·87	12·19	?	0 376	97	0·75	23·34
Charcoal furnace at Stjernfors, . .	259	1	949·35	41·22	793·08	12·66	?	0·469	121	0·78	23·04
Charcoal furnace at Gustafsfors, . .	204	9	1008·65	42·80	836·97	12·89	?	0·466	115	0·75	22·66

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[*] Throughout this paper it must be borne in mind that the French *tonne* of 1000 kilos. is used.

OBSERVATIONS.

The two furnaces working with charcoal served at the same time as furnaces of reserve to that working with sawdust, and operated simultaneously only in the single case where the latter needed repair. During the first six months 789·13 tons of iron were drawn out into bars, and during the following six months 1013·11 tons, of which 557·27 tons were produced during the three latter months, this being equivalent to an annual production of 2229·14 tons. The furnace with the sawdust has produced during the three last months of the year—that is to say, during 56 days (of 24 hours each) and 20 hours—471·18 tons, being equivalent to an annual produce of 1884·74 tons, or 8½ tons during 24 hours. After each repairing of the furnace 304·55 tons were drawn out, all the iron being twice reheated. The consumption of sawdust was not observed with regularity, but it is valued at 0·776 metres per 100 kilogrammes, according to careful calculations made during the latter half of the year. During the last week 750 cubic decimetres of sawdust were used for each 100 kilogrammes of finished iron.

As a comparison of the different effects for the different reheating furnaces was not observed on the spot, the values given in the above table have been obtained from the books of the Stjernfors, Gustafsfors, and Munkfors works, comprising the year 1866 as well as the four preceding years. The considerably less consumption of charcoal for the Munkfors furnace, as compared with that of Stjernfors and Gustafsfors, is due to the excellent quality of the charcoal employed at the first-mentioned works. In comparing the quantity of carbon used in the sawdust furnace and in the charcoal furnace, it will be found that in the former case 300 kilogrammes of iron are reheated with the same quantity which reheats but 100 in the second case; so that by what we have said it is evident how greatly the produce of regenerative furnaces in Sweden has been increased.

In conclusion, we may give some of the last-mentioned results. Since November 10, 1866, up to April 18, 1867, or during 105 days of twenty-four hours each, 926·06 tons of iron have been reheated and drawn into bars, with a loss of 12·04 tons per 100, and with 0·76 metres of sawdust per 100 kilogrammes of iron. In one week 56·18 tons of iron were drawn into bars, with 0·617 metres of sawdust per 100 kilogrammes, the loss being only 9·90 tons per 100. At present the average loss is 11 tons per 100.—V. D.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

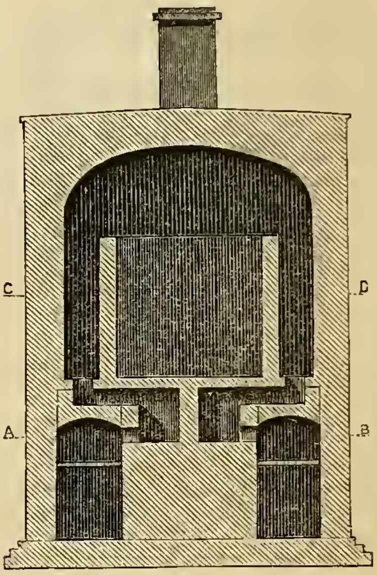
No. XXXI.

Malleable Castings.

Though a little out of its place here, we may further corroborate what we have already stated with regard to Reaumur's having been merely a *re*-discoverer, if one at all, as regards the method of making malleable cast-iron work, and having had much information to guide him. In the third section of those (for the period) grand memoirs upon iron ores and iron making, &c., by the Marquis de Courtivron and M. Boucher, addressed as reports to M. de Malesherbes, then president of the "Cour des Aides" of France—in that section which treats of furnaces they say: "M. Reaumur having remarked the dark colour of ordinary castings in iron when cut, filed, &c., and endeavoured to obtain a more bright-coloured metal, "il a fait des expériences qui l'ont conduit à obtenir des fontes trés-blanches, consequemment trés-durs; *il a retrouvé le secret d'adoucir*, de rendre traitables ces fontes pour les travailler, avec le moyen de les durcir quand elles sont travaillées. Enfin il a reussi à faire des ouvrages de fer fondu, qui avaient la blancheur et l'eclat des beaux ouvrages de fer." There is here again, we may observe, the same unqualified statement that Reaumur had only found out what had been well known before his own time. What makes this passage chiefly remarkable, however, is the statement with which it concludes; namely, that Reaumur had discovered the means not only of making white pig iron soft and malleable, but of again hardening it so as to give it the whiteness and lustre at least of (polished) works in good wrought iron. No distinct traces of the way in which this was effected are discoverable, so far as the writer is aware, in anything left after him by Reaumur. We shall revert to this, however, when treating of the probable theory of the process of cementation.

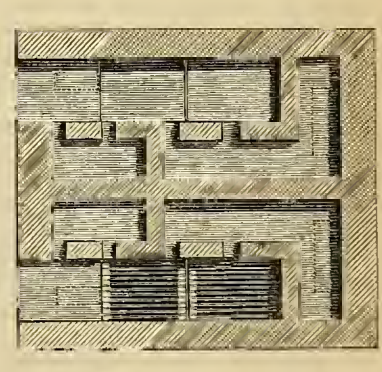
The modern forms of annealing furnaces are shown in figs. 10 to 12 inclusive, which represent the ordinary form much in use about Sheffield, Birmingham, and at Manchester; and in figs. 13 to 15 inclusive, which represent the regenerative gas furnaces of Mr. Chas. W. Siemens applied to this special use, as actually constructed for Mr. Thomas Francis, of Birmingham. For these detailed drawings of the last the writer has to express his acknowledgments to the inventor of the gas furnace, and designer of this, who very liberally has enabled them to be placed before our readers.

Fig. 10.



In the ordinary kiln the mouths of the two furnaces seen at either side below, are sometimes provided with iron furnace doors, sometimes only stopped with lumps of coal, until the heating up is complete, when they are bricked and clayed up. A large arched opening in front is provided for getting in and out the annealing pots, and is bricked up when the charge is in place. Fig. 11 is a horizontal section above the fire grates at A B, fig. 10, and fig. 12 another above the furnace floor at the level of C D, same fig., fig. 10 being a vertical section through E F. These furnaces are lined with refractory brick, and generally bound with iron straps and ties on the outside. The interior rectangular wall, as seen in figs. 10 and 12, is intended to defend the annealing pots from the direct action of the flame and gases from the fires, and no doubt tends much to prevent their rapid destruction by external scaling. Furnaces *generally* upon this construction are in use without any internal walls, the flame not passing, as here, under the kiln floor beforehand, but rising at once into the open body of the kiln and up amongst the pots.

Fig. 11.

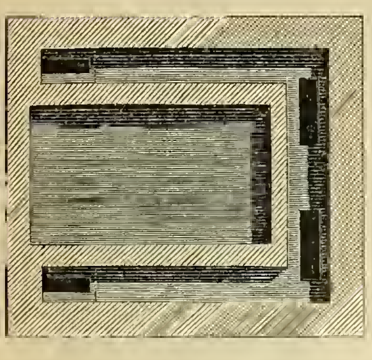


The malleable cast iron manufacture is as yet nowhere upon so extensive a scale as to make it worth while, but were it sufficiently expanded there can be no doubt but that the conjoint application of the Siemens' gas furnace (as below described), and of the Hoffman *continuous* system of kiln-working, as exhibited in his patent brick kilns, would be the perfection of the annealing process, for in that way *none* of the heat of the fuel would be wasted, and the operation of annealing would be continuous; and the annealing pots that were done, being heated for a given operation, would be cooled, and rapidly so, by the draught of air passed through them to feed the furnaces, or burn the small coal thrown in promiscuously amongst the annealing pots. This use of the Hoffman kiln might, we believe, have been worthy of a separate patent.

In the working of these ordinary annealing furnaces with articles of the usual *larger* sizes—such as stirrup irons, &c., about Birmingham, or cotton machinery in Lancashire—the whole annealing process occupies nearly ten days. The annealing pots are put into the furnace during Monday, the furnace is lighted that night or on Tuesday morning. The heat of the furnace continues to increase up to about the following Friday or Saturday, when it is found to have reached a clear yellowish white heat, but of course less than that of the fusing point of white cast iron. This heat is maintained steadily for twenty-four hours, say until Sund or Monday night, when the apertures are bricked or otherwise closed up nearly air-tight, and the temperature let to decline. Sometimes a little air is permitted to pass through so as to reduce the temperature rather more rapidly; and the cooling is usually so complete by about Wednesday morning that the breast of the kiln may be taken down and the pots freely exposed, when they soon cool down so that they can be handled and taken out.

No instrumental means of judging of the progress of heating, nor of the maximum heat attained, seems to be anywhere employed. The eye and habitude alone judge of these. Overheating seems to be very unfrequent, unless to the point of needlessly agglutinating together the particles of hæmatite powder, and getting this adherent to the castings. But insufficient heating seems rather more usual, and from various reasons, which we may readily discern, this is likely to be the case. These ordinary furnaces are constructed of different sizes, but none are more than a foot or two larger or smaller than those in the figs. above referred to.

Fig. 12.



Mr. Siemens' regenerative gas annealing furnace, shown in fig. 13, is a transverse section through A B, fig. 15; fig. 14, a longitudinal section at E F, fig. 13; and fig. 15, a horizontal section at L M, fig. 14. The gas generators are not shown in the figs. The central arched chamber of the kiln, it will be seen, is a closed arched *muffle*, in which the annealing pots or cases are placed. The hot gases and hot air, being kindled, pass beneath at the sides, and all over the top of the arch of this, and the products of the combustion pass away through the bricks occupying the gas and air chambers beneath the other side of the furnace.

When the time comes for making the change, the draft is reversed by means of the dampers on the gas and air flues, seen to the right hand in fig. 14, and the heating goes on as before, but the currents of flame play in the direction opposite to that before.

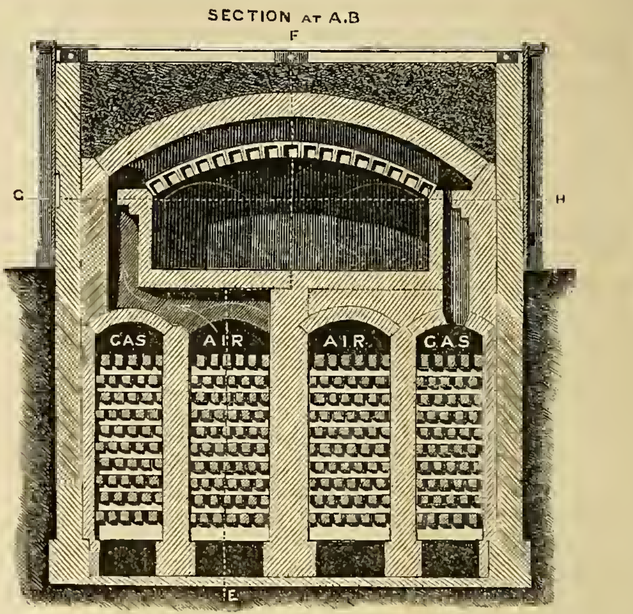
As we may assume our readers well acquainted with the general principle of the Siemens regenerative furnaces, which have now a world-wide reputation, we need not dilate upon it here.

No application of the principles of these furnaces can be more happy than the present, from the admirable facility of adjusting the nature of the gas flame, so that it shall have the least possible injurious or scaling effect upon the iron annealing pots, as well as in the great economy of fuel. The Siemens furnace is never let to cool entirely; the annealing pots are introduced and withdrawn by suitable tools, and permitted to cool on the floor: thus great economy in time as well as in fuel is achieved.

At Mr. Francis' foundry, in Birmingham, over which we were very liberally shown recently and with perfect unreserve, we were informed that in about eighteen hours a charge for this furnace was brought to a bright red heat, and that the temperature was kept slowly advancing for about sixty hours to seventy hours, and then permitted to decline for about twenty-four before the pots were withdrawn and a new charge put in. The work at this foundry, some further details of which we are about to give, is all of the very smallest and finest character, so that a shorter time of annealing answers than with heavier articles.

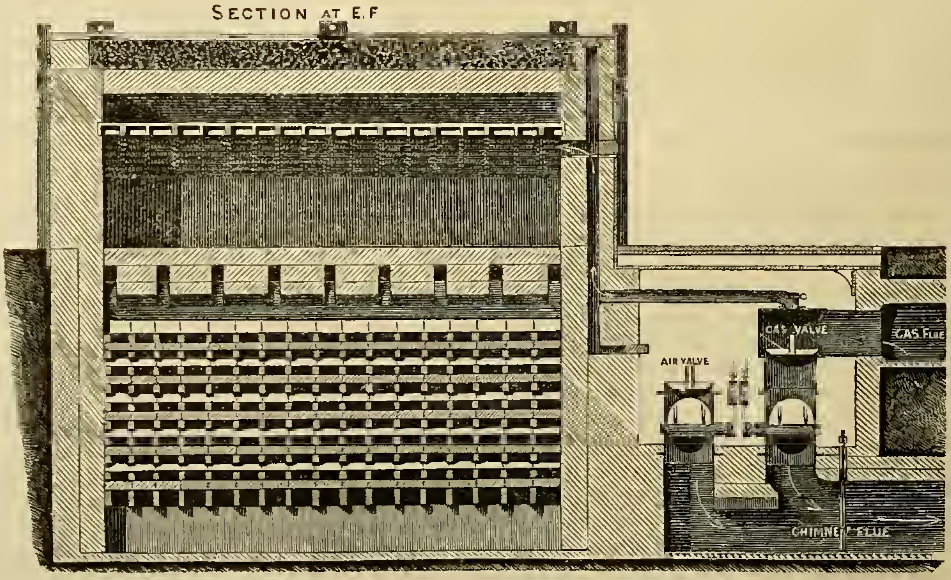
In general, however, within the limits of size (or scantling, rather) possible with existing methods, the duration of annealing lasts from a minimum of five days in all to a maximum of ten or eleven. The annealing, though far from a difficult or risky process, is one of some little delicacy. If air gain free access to the intended malleable articles; if the heat rise too high, or do not reach a clear bright red approaching to a deep yellow heat; if the fresh or before unused hæmatite be mixed with too little of the old (or as we shall see further, of *some diluting* material)—the annealing is incomplete, or the articles, when they are withdrawn, are found scaled and oxidated at their surfaces, and perhaps still white and brittle within; or, if too highly heated, hæmatite is actually fused on in places to their surfaces, and the articles themselves are bent and distorted. Some of these rare accidents admit of being cured by a second annealing, but the others result in the destruction of the charge or content of the furnace.

Fig. 13.



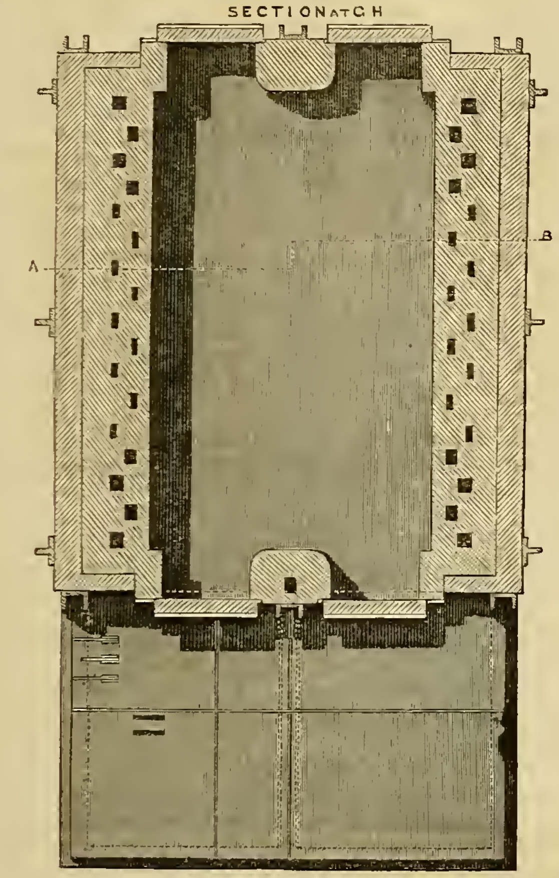
After the withdrawal from the annealing furnace, cooling, and "fettling" or cleaning from all adherent matter, the malleable castings *may* be complete and ready for market; but in many cases the articles cast undergo other processes at the hand of the malleable-iron manufacturer before they are ready for sale. Of these some notion will be given in the following description of two "malleable foundries" at present at work. The practice in Belgium, as we have stated,

Fig. 14.



differs almost in nothing from that pursued in Great Britain, nor are there any important differences in Germany. The few points in which there are differences may be perceived from the following description of the process as there conducted, abridged from an article in the *Zeitschrift des Vereines Deutscher Ingenieure*, the "Journal of the Association of German Engineers." The manufacture of malleable cast iron is conducted by the fusion of the cast iron in covered black-lead crucibles of 60 lbs. capacity. Scotch pig iron and pig iron free from sulphur and phosphorus are melted in a wind furnace containing four crucibles. So high is the temperature that a red-hot iron bar, dipped into the melted cast iron, directly falls off, like falling stars. The crucibles are lifted out and poured into the moulds. These sand moulds, as for example for keys, parts of locks, etc., must contain in convenient places so-called "*suckers*," reservoirs which fill themselves during the pouring, and out of which the cooling casting sucks up or feeds itself as it contracts. Are such suckers wanted, is questionable. Cavities must occur in these places. During the founding the moulding-boxes are placed vertically or very much inclined. The annealing of the castings is performed between layers of red hæmatite placed with them in square cast-iron boxes of 1 inch thickness, closed on the top with a cover. The annealing furnace is constructed in such a manner that the fire-grate is in the front part, and that the hot gases and flame go round these boxes, which are placed in the rear part of the furnace. Through an eye hole in the side the progress of the heating in the inside may be observed. The firing must be sharp in the beginning, in order to attain a certain degree of temperature, after which it is fed or fired at regular intervals, for such time as may be deemed necessary.

Fig. 15.



For a total weight of 7 to 9 cwt. of castings, three, four, up to five days are required as the time for annealing. Heavy and light pieces are put in separate furnaces, or in different parts of the same; the former nearer to the fire than the latter ones. After the pieces have gradually cooled, they are taken out and cleaned. The right degree of heat for the annealing can only be known by experience. Very often the cast-iron annealing boxes cannot be used any more after the first time of applying them to use. Malleable cast iron, the author adds, is not yet used as much as it might be for parts which have to be numerously repeated; parts to be executed only once or twice will be dearer, if thus made, than if forged. The prices per pound are for—

	Pence British.	
Pieces of 2 lbs. and more,	from 5·4	to 6
" 1 lb. to 2 lbs.,	" 6	" 6·6
" ½ lb. to 1 lb.,	" 6·6	" 7·2
" ¼ lb. and less,	" 7·2	" 7·8

These prices are understood to apply to central and western Prussia.

Messrs. Lucas' works at Dronfield, which, as being the cradle of the manufacture, have an historical celebrity, are situate beside an ancient Hallamshire brook in the pleasant vale and in the village of Dronfield, about six miles from Sheffield. The branches of the trade with which the works are now chiefly occupied are—in the casting of parts of agricultural and of textile machinery; in various hand-tools and parts of cutlery; in garden and agricultural tools; and generally in the execution of all orders for which designs or patterns are sent them. They thus present a very varied course of manufacture. We saw there ends of cotton roving rollers, with perforations of ½ inch in scantling (thickness); a large sluice frame, presenting scantlings of 1¼ inch or so, which, though annealed, had proved a very difficult and refractory task, owing to the bending and distortion it underwent in the annealing furnace; and innumerable small articles of all shapes and sizes. Amongst the latter, nothing gave a higher testimony to the skill and excellence of their work than the hollow taper ferules they make for the fork-end of hay-forks—that end into which the tang is driven. These ferules are about 1½ inch diameter at one end, and 1⅛ or so at the other; about 4 or 4½ inches in length; and are cast hollow upon sand cores. They are not more than $\frac{1}{20}$ inch or thereabouts in thickness, and do not differ sensibly in thickness anywhere, when hundreds are examined at random. When first cast from the greensand, they are as brittle literally as glass; one of them let fall on a stone floor flies to pieces. After annealing, a ferule may be hammered up close and flat, and even opened again without fracture. A cylindric shaft and little crank for cotton machinery, of about ¾ inch diameter, was bent double with the hammer before us without a crack.

The works comprise a small ordinary foundry, with cupola, &c., making jobbing work to order and for the use of the works, with all the usual attributes—a smiths' shop, with some of Ryder's forging machines employed on very small iron and steel forgings for cotton machinery; a fitting shop; and the several parts of the malleable foundry proper. The malleable work is almost wholly done by pot-founding and bench-moulding, larger work than can be thus commanded, if any, being executed in the jobbing foundry. The pot-foundries consist of a considerable number of quite separate and distinct shops, each of small size, well lighted and ventilated, and presenting each, with its busy inhabitants, a very pleasant look of happy and primitive-looking industry, the open door of each looking out upon the sunny meadow sides at the opposite flank of the valley. Each foundry is provided with three or four wind-furnaces (all of which nearly, are above ground, *i.e.* the ash-pits in the foundry), with its own little stoves for drysand, and its own stock of boxes and other tools.

One workman or two are "monarchs of all they survey" in each one shop, and are assisted by several boys and labourers. The moulding work, according to its purpose, is either greensand or drysand. The Rowseley sand used is loamy and very fine. Charcoal and fine coke-dust blacking are used at the judgment of the moulders. The work is all done by piece work, so much per cwt. for all good castings, which is paid to the piece master or leading moulder, who pays all his assistants. All materials are provided by the proprietors. Brass patterns are almost exclusively employed, and brass core boxes for the drysand cores; where the articles are not to be repeated very often, wood patterns of sycamore or of box take their place. They do not make any extremely small work, such as nails, &c. One peculiarity we observed here as regarded the annealing process. In place of the annealing pots being piled up in the furnace with nothing but air in the interspaces between them, these are filled up solidly, as the ranges of pots are put in, with screened and washed cinders from the furnace ash-pits in uniform pieces about the size of small walnuts. It was stated that these scarcely burnt away at all in the furnace, and that the method was thought to afford better work, and certainly protected the annealing pots themselves from scaling, and produced a slower cooling, which was deemed advantageous.

The usual practice here is to leave the small work in the furnace 84 hours after it has attained its full heat, and larger work still longer; and with the very largest, such as treddle cranks (apparently for foot-lathes, and possibly sewing machines) of about 1¼ inch diameter, to anneal a second time, of equal duration.

Owing to the presence of water and of chloride of sodium in minute quantity in the fuel, &c., some of the red and black (or already used) hæmatite *sublimes* in the annealing ovens, and now and then forms very beautiful crusts of iridescent crystals, which are in fact artificial "Elba iron ore," and almost precisely like those which are formed in just the same manner at the craters of Vesuvius and Etna, and most other volcanoes.

No women or girls are employed in the works, but many boys. The works at large present a very pleasant aspect of contented and wholesome industry. These works date from 1810 or 1811. About that time, one William Grove, of Birmingham, had commenced a trade there in malleable castings for coach harness, coarse cutlery, &c. A trial between that person and Samuel Lucas, of Dronfield, established the value of the process in the eye of the public, whatever else it may have done as regards individual rights, and the trade sprung up and increased with vast rapidity in Birmingham and its neighbourhood. Small malleable castings, such as for forks, snuffers, &c., were sold about 1820 for 10*d.* per pound, and like can now be had for rather less than half that price.

One firm in Birmingham, that of Mr. Thomas Cardall, is mainly engaged in the manufacture of stirrup-irons and bits, and horse furniture generally, for home and foreign markets. He is said to possess patterns for about 3000 different sizes or patterns; and other foundries have patterns for 4000 or 5000 sorts and sizes of keys. At the above-named foundry, about two tons of horse furniture is made per week when trade is good, of which nearly one-half consists of stirrup-irons. There is no malleable foundry in or about Birmingham which we have visited of equal interest, however, with that of Mr. Thomas Francis (whose Siemens' annealing furnace we have illustrated), both from its extent and from the excessive minuteness of the work executed. This consists mainly of nails—horse and mule shoe nails, tips and shoes for mules, buffaloes, and oxen included; nails or pegs, and clouts of innumerable patterns, lengths, forms, and sizes, for the soles of boots and shoes, "for the dwellers in every country under heaven" almost; coffin nails and coffin furniture, rivets, screws and screw-blanks, washers, and a vast array of miscellaneous work, almost all small and fine. Many of the patterns of shoe nails are so minute that some hundreds go to an ounce, and the points of these minute bits of metal are as sharp literally as pins or needles. The foreign trade is principally with France, Spain, Brazil, and South America generally, Italy and the Levant, the West Indies, and the United States. When trade is good, they turn out sometimes *seventeen tons a week* of nails of various sorts.

All the work is moulded by hand from minute brass patterns, and this is the only part of the manufacture that appeared to us to admit of immense improvement. It is known, no doubt, to many of our readers, that brass or bronze and copper nails (clout nails) are cast to a great extent, and these are all moulded in greensand by machinery. The copper clout nails employed to so vast an extent for coppering the hulls of vessels, in the day when "Hearts of oak were our ships," and the Muntz metal clout nails used for yellow metal sheathing, are all so cast; and any one may see the simple and efficient machinery employed for the purpose at work in the metal mills at Portsmouth dockyard and elsewhere. There is no conceivable reason why this same system might not be employed here in moulding malleable nails and tacks, and with immense saving in time and wages. On inquiring at Mr. Francis' works, however, we found that his managers (we unfortunately did not see the proprietor, who was abroad) professed to be wholly ignorant that any such machinery was in existence. The melting is performed in 56 lbs. clay pots, made in the works, heated with coke in ordinary wind furnaces. The sand is from Moseley, very fine and loamy, and used without clay-wash, charcoal, or coke dust.

There are about fifty hands employed, none of whom are women or girls. All the work nearly is piece work, with one exception to be presently mentioned all materials and tools being found by the proprietor. The boxes are chiefly of light cast iron, those most employed being of malleable cast iron. There is a jobbing foundry and cupola for casting the annealing pots, a mill to grind sand, hæmatite, &c., and various subsidiary shops for repairs, &c., and large ranges of stores and packing rooms. The premises do not occupy a large area, probably not more than 60 or 70 yards by 40 or 50 wide. An engine of about 15 horse-power works all that needs power, viz., the fan-blast, hæmatite mill, revolving scouring barrels to "fettle" the sand and the hæmatite from the nails, &c., drive grindstones, and some lathes and like tools. Until recently all the annealing was done in the old form of furnaces, but not long since two of Siemens' gas furnaces have been put up and are stated to work admirably. The nails, as a rule, are finished by causing them to revolve in the barrels with black-lead powder, the black-lead used being chiefly Mexican; by this they acquire a beautiful polish and dark black-gray tint. For some markets, however, the nails, especially the shoe nails, are demanded to be coated with a black japan; for which purpose, being on completion moderately heated in an oven, they are plunged into a black asphaltic varnish (which is purchased for the special purpose, and the exact composition of which was not known to the founders) in a bath, out of which they are taken and drained at a high temperature upon a sieve, and when quite free from "tackyness," are packed like the others in coarse rope "nail bags." The varnish appears to be of coal pitch, with perhaps some gum elemi, dissolved in naphtha. In Germany, the writer has been informed that a coarse amber varnish is employed for the like purposes, made from the refuse amber of the amber bead and pipe works, fused with asphalte, and then dissolved in some liquid hydrocarbon, probably alcohol and turpentine.

The nails for coffin mounting and for upholsterers' use are treated differently. As soon as these have been cleaned in the revolving barrels, they are washed briskly upon an iron wire "riddle," and then thrown into large cast-iron vats, full of water, which covers them completely. It is a striking illustration of the chemical fact, that water, free from combined air, has no action upon iron at atmospheric temperatures, to see here that the water contained in these vats, once it has become exhausted of its combined air by oxidizing the first lot of nails thrown in, ceases to do so as respects those afterwards submerged in it, but, on the contrary, protects them from oxidation as completely as if they were immersed in naphtha or oil. These coffin and upholsterers' nails have hollow, thin, broad heads, in exterior contour a segment of a sphere or ellipsoid, and are cast surprisingly smooth upon the upper part or exposed face. About 50 lbs. weight at a time of these nails is taken out of the water, and some powdered sal-ammoniac is sprinkled over them, and they are thrown into a small cylinder of plate iron, which revolves by hand upon a horizontal axis over a small coke-cinder fire. About *two ounces*, not more, of grain tin is thrown into the cylinder along with the nails, as soon as the latter have got heated, with a little tallow; and the revolution over the fire is continued, occasionally taking out a sample, to judge of the progress of the tinning, through a small sliding door at the side of the cylinder. When the tinning is complete, this door is fully opened. The nails are shaken out of the cylinder, and fall at once through a shoot, contrived so that the nails must separate in passing down it, by their own weight, and so not be found soldered together in twos and threes, and are dropped into water. From this they are taken out, dried over a hot plate in warm dry sawdust from any wood free from turpentine, and are then weighed and packed into bags. The lustre of these tinned nails, straps, coffin handles, &c., is quite surprising, and so is the extremely small quantity of tin which forms the thin coating on their surfaces. The workman who performs the operation is paid by weight, and is found in all materials except the tin, which he has to provide. Thinness of coating is essential to beauty, and this is secured by the financial arrangement described, as well as pilfering of a dear metal prevented.

It would be a breach of confidence were we to state anything as to the rate of wages or the prices, in respect of either of the establishments which we have referred to. We may state, however, that the average wages of "malleable moulders," taking Birmingham, Sheffield, and Manchester together, is about 8*s.* per cwt. of good work, and that their weekly earnings are, at that rate, from 33*s.* to 37*s.* per week. The British makers of malleable castings endeavour to keep up high prices, and so stand in their own way of any effectual attempt to greatly extend their manufacture. £32 per ton has been not long since asked for a very large quantity of very simple forms, for a part of a system of railway permanent way, for which just one half, or £18 per ton, would have subsequently been accepted. In this case, however, as in all where the quantity is large and the forms such as can be produced by rolling or other machinery in wrought iron, the latter quite beat the malleable founder out of the field, and what he could not or would not execute under £18 per ton was done in wrought iron for £11 10*s.* The price of malleable castings in France and Belgium is from 1·30 to 2·50 francs the kilogramme; or say, from 6½*d.* to 1*s.* 1*d.* per lb.

The statistics of the trade show that in Great Britain its seats are in and about Birmingham, Sheffield, and Manchester, the average prices being from 8*d.* to 16*d.* per lb. Nothing is known precisely as to the annual production. We exclude Messrs. M'Haffie, Forsyth, & Miller's so-called "improved malleable cast-iron;" for although it may be iron in some form—be cast and be malleable—it is not "malleable cast iron" in the accepted sense, nor in that of which we have been treating. In France there are several malleable foundries in Paris, and twelve or more in Normandy and Picardy. The annual production in all France is stated to be about 1500 tons. In Germany the only seats of the manufacture known to us are in Stuttgardt, in Westphalia, and in Wirtemberg. The average price is stated by Brühll to be higher than in France, viz., 2 francs the kilogramme. Nothing is stated as to the total production of Germany by Dr. Wiebahn in his great work, the *Statistic des Deutschlands* for 1862. There is one malleable foundry at Schaffhausen, in Switzerland, and, we have understood, another at Zurich. The Belgian trade is concentrated about Herstahl, as already stated, where a large number of establishments are employed with cutlery, hand tools, domestic and divers appliances and instruments, and in the parts of small arms. Liege may be considered the headquarters of the trade. Of the total yearly product we have no information. One foundry is stated to exist in Spain, at Guipuscoa, employed on cutlery, small-arms, and the mounting for cutting weapons, &c. Brühll states that much malleable castings are made in the United States, but we have no information further as to the manufacture there.

It remains for us, in a concluding paper, to treat of the physical and other properties of malleable castings, and to offer some remarks as to the probable theory of the process.—Ed.

ON THE CHEMICAL HISTORY AND REACTIONS INVOLVED IN THE FORMATION AND IN THE SETTING AND HARDENING OF PORTLAND AND OTHER CEMENTS OF THE LIKE CLASS.

The following careful memoir, contained in a recent part of the German civil engineers' journal (*Zeitschrift des Vereines Deutscher Ingenieure*) for April, 1868, deserves being known in England, not only as an example of the exhaustive care with which German science pursues technical questions, but for the matter which it conveys, and which is not commonly yet known to English readers.

Erdemann's Journal for 1867, vol. 100, pages 257 to 303, contains, under nearly the above title, a comprehensive article by Dr. W. Michaelis, in which he publishes a very careful critique of the existing opinions upon the Portland cement, and demonstrates by several important experiments, based upon the practice of many years, the way to produce faultless cement.

Formerly those substances were understood under "cement" which, mixed with lime, produced an hydraulic mortar. All these admixtures contain silicic acid in a soluble form, and are chiefly tarras, puzzolana, and santorin earth (of which the author gives the well-known analyses of Berthier, Elsner, and Vohl). At present the word cement is generally applied to "mortars which get hard under water." The "Roman cements" (the name originated with Parker, its inventor, who, by burning the calcareous pebbles of the isle of Sheppey, produced a water mortar which was similar to that manufactured by the Romans from puzzolana) are made from naturally existing argillaceous limes which, burnt at a low temperature, produce a light to dark red-brown dusty powder, which easily attracts carbonic acid and moisture. The Portland cements (called after the building-stone so much valued in England as "Portland stone," to which the hardened cement is somewhat similar in colour and strength) are produced from rough masses of clay and limestone mixed together in certain proportions,* which are burnt at a high temperature, much higher than that needed for the removal of carbonic acid, which is not sufficient. The powder produced being sub-crystalline and of a greenish-gray colour, possesses a higher specific gravity and attracts carbonic acid and moisture more slowly. The Portland cement, when mixed with water, hardens in a much shorter time and attains an increasing greater hardness in the air as well as under water. The following analyses of different sorts of Roman and Portland cement may be usefully tabulated:—

ROMAN CEMENTS.

	1. Limestone (Upper shell-lime) Muschelkalk, from Krienberge, near Rildersdorf.	2. Limestone Boulders, from Sheppey.	3. Limestone (upper shell-lime form) of the lead-bearing formations of Samaritz.	4. Mixture of rich and clay Limestone from Hamberger.	5. Limestone from Metz.	6. Limestone from Halkin mountains, near Holywell, Flintshire.
Lime, . . .	58·38	55·50	47·83	58·88	68·8	78·31
Magnesia, . .	5·00	1·73	24·26 (?)	2·25	2·3	3·00
Silicic acid, . .	23·83	25·00	5·80 (?)	23 66	18·5	13·81
Alumina, . .	6·40	6.96	1·50	7·24	5·7	4·86
Oxide of iron, .	4·80	9·63	20·80	7·96	4·4	
	98·41	98·82	100·19	99·99	99·7	99·98

PORTLAND CEMENTS.

	1. English, from White Brothers. (Michaelis.)	2. Stettin Cement. (Michaelis.)	3. Wildau Portland Cement (Michaelis.)	4. Wildau Portland Cement (Michaelis.)	5. Stern Cement, from Stettin. (Michaelis.)	6. Stettin Cement. (Michaelis.)	7. English Cement. (Hopfgärtner.)	8. Bergwerks and Hutten Verein at Bonn. (Hopfgärtner.)	9. Kraft & Saullich Perlmoos. (Feichtinger.)
Lime, . .	59·06	62·81	61·91	60·33	61·64	61·74	55·06	57·83	55·28
Silicic acid,	24·07	23·22	24·19	25·98	23·00	25·63	22·92	23·81	22·86
Alumina, .	6·92	5·27	7·66	7·04	6·17	6·17	8·00	9·38	9·03
Oxideofiron	3·41	2·00	2·54	2·46	2·13	0 45	5·46	5·22	6·14
Magnesia,	0·82	1·14	1·15	0·23	—	2·24	0·77	1·35	1·64
Potass, .	0·73	1·27	0 77	0·94	—	0·60	1·13	0·59	0·77
Soda, . .	0 87		0·46	0·30	—	0·40	1·70	0·71	—
Sulphuric acid, . Lime, .	2·85	1·30	—	1·52	1 53	1·64	1 75	1·11	3·20
Clay, . . Sand, . .	1·47	2·54	1·32	1·64	1·28	1·13	2·27	—	1·08
	100·20	99·25	100 00	99·84	95·75	100·00	99·06	100·00	100·00

CLAYS SUITABLE FOR ADDITION TO LIMES, TAKEN AS FREE FROM WATER.

	1. Medway Clay. (Feichtinger)	2. From the Elbe Prov., Saxony. (Michaelis.)	3. Pomeranian Clay. (Michaelis.)	4. Upper Hartswald. (Michaelis.)	5. March of Brandenburg. (Michaelis.)
Silicic acid, .	68·45	60·06	59·25	60·00	62·48
Alumina, . .	11·64	17·79	23·12	22·22	20·00
Oxide of iron, .	14·80	7·08	8·53	8 99	7 33
Lime, . . .	0·75	9·92	—	4·18	6·30
Magnesia, . .	—	1·89	2·80	1·60	1·16
Potass, . . .	1·90	2·50	1·87	1·49	1·74
Soda, . . .	2·10	0·73	1·60	0·72	0·37
——	—	0·60	2·73	0·89	0·60
	99·64	100·57	99·90	100·09	99·98

The dispute which during the last ten years has arisen about the theory of the hardening of the Portland cements, although not yet finally decided, deserves a consideration in this journal from a practical point of view.

Professor Fuchs (*Erdemann's Journal*, vol. 6, pages 1 and 132) first gave a scientific explanation of that which takes place during the hardening of hydraulic mortars, showing by experiment that under the influence of the water a chemical combination takes place between silica and lime hydrate. Winkler, in 1856 (*Erdemann's Journal*, vol. 67, p. 444; *Dingler Polytech. Journal*, vol. 142, p. 106), laid down the rather different opinion that there are two different classes of cements, the first of which (containing the so-called Roman cements of slightly burnt hydraulic clay limestone, mixtures of puzzolana, tarras, brick-dust, &c., &c., with lime), according to him, in a fresh condition always contain caustic lime, and for these he accepts the theory of Fuchs; the second class, under which he takes the Portland cements, and which, as he affirms, do not contain in a fresh condition any caustic lime, undergo another chemical change during the hardening, according to which, under the influence of the water a basic-silicate ($1 SiO_3 + 3$ or $4 RO$) separates into free caustic lime, and into such combinations as are formed in the Roman cements between caustic lime and silica, or between acid silicates. This separation of caustic lime takes place during the whole time of the hardening of Portland cement, and the remaining silicate will be afterwards identical with the one formed in the Roman cements. It would lead us too far to go back to the chemical researches which led to these conclusions. Feichtinger, in 1858 ("Jahresbericht von Wagner," 1858, p. 214; 1864, p. 266), controverts experimentally this opinion of Winkler, and tries to prove the correctness of the theory of Fuchs as applicable to the Portland cements. Winkler replies (*Dingler's Journal*, 1865, vol. 175, p. 208), and finds in the experiments of Feichtinger merely a confirmation of his own opinion, which he endeavours to sustain by further experiments, to which Feichtinger (*Dingler's Journal*, vol. 176, p. 378), point by point, gives a complete answer, defending the theory of Fuchs. Winkler (*Dingler's Journal*, vol. 178, p. 223) does not accept that, but gives the important and since then published experiments of E. Fremy ("Compt. Rend.," 60, p. 993; or *Dingler's Journal*, vol. 177, p. 376) and of W. Heldt (*Erdemann's Journal*, vol. 94, pages 129 to 161, and pages 202 to 237) in favour of his own opinion. We will try to give a brief but correct account of the dispute, but must refer to the original articles, as this difficult question has not yet been solved in a clear and incontestable manner.

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* The cement manufactured in the works of Kraft and Sanllich, at Perlmoos, near Kufstein in Tyrol, by simply burning the stone which is found in great quantity near Horing, belongs by its composition and its physical condition, doubtless, to the Portland cements. A paper respecting this cement, which has been found by practical experiments perfectly equal in value to the best English cement, by George Rebhann, occurs in the *Journal of the Society of Austrian Engineers and Architects*, 1864, pp. 13 and 63. The stone is burnt with brown coal (lignite) without any further preparation, at a great heat till it begins to fuse, and is then ground.

Winkler treated 1 gramme of Portland cement for eighty-five days with 1500 times its volume of water, and dissolved out of the 0·52 gramme of lime which the cement contained, 0·191 gramme of lime, and besides 0·045 of alkalies, silica, &c.

1. *Statement according to Winkler.*—The basic silicate of the Portland cement separates during the hardening into a silicate, which is composed like the one formed by the Roman cements (according to Fuchs), and into free lime, which the cement, before its treatment with water, only contains in combination with silica, &c.

2. *Statement according to Feichtinger.*—The reason for the gradual separation of lime is that the free lime in the Portland cement (which is to be found in any cement) is everywhere entangled by coagulated (*i.e.*, partially indurated by heat) alumina, and thereby the influence of the water upon the lime and its solution are retarded.

3. *Winkler*, against No. 2, urges the fact that alumina and free lime cannot exist in contact with each other at high heats without combination, but that the free lime will be taken up and basic silicates formed, which, however, must not be fused.

4. *Feichtinger.* Against No. 3.—The alumina must only coagulate or indurate, and not fuse so far as to effect its combination with the lime. In order to effect that, a complete fusion (vitrification) of the whole mass of the cement would be necessary, and practice has shown that in such case the cement would be useless (burnt, as the workmen call it).

5. *Winkler.*—The process of hardening is a double one: a physical one, so far as it comprises the cementing together of the separated pulverulent particles; a chemical one, so far as the molecules are brought into motion through chemical reaction, and so facilitate the cementing. The separating lime penetrates the pulverulent particles and produces then the cementing.

6. *Feichtinger.* Against No. 5.—A certain time after the mixing with water the pulverulent particles are surrounded by solution of lime instead of the simple waters used at first to wet the powder, and this lime water, after being once saturated, cannot dissolve anything more. Any further solution is only possible if fresh water be added (that is, however, *not* the condition of the hardening), or the lime already in solution separated from the water (through carbonic acid and silicic acid), &c., which is not here the case.

6. *Feichtinger* mixed together Portland cement with a concentrated solution of carbonate of ammonia; no hardening took place, and a great deal of carbonate of lime was formed; having the superabundant carbonate of ammonia afterwards removed by washing with water, and having dried the cement, no hardening took place upon mixing it with water. But the powder hardened as soon as he added to it some lime hydrate. Again he passed for one or two hours, into water mixed with a little Portland cement, a stream of carbonic acid: there was formed much carbonate of lime, often as much as 27 per cent. The powder was then dried and would not harden with water, but as soon as he added lime hydrate it hardened like fresh cement.

7. Experiment 6 shows, according to Feichtinger, that the Portland cement contains silicates or free silica, and that the hardening, produced through the addition of lime hydrate, is not explicable by the theory of Winkler.

8. *Winkler.* Against No. 7.—The free silica has only originated in consequence of the breaking up of the silicates of the fresh cement by the reaction of the carbonic acid or by that from the carbonate of ammonia, and the smallest particles being most rapidly broken up thus, and before the larger ones, these remain more or less untouched in the interior. The result of the experiment (6) is therefore a mixture, consisting of (α) carbonate of lime and neutral silicates, (β) unaltered cement inside the coarser particles, (γ) acid silicates and free silica, and clay. That the still unaltered particles of cement do not harden is a consequence of their coarse mechanical texture, *i.e.*, their large size, of the slime lying interposed between them, consisting of neutral silicates which form their surfaces. The hardening through lime hydrate is produced through the substances mentioned under (γ).

(e) *Feichtinger* treated under similar circumstances (α) precipitated carbonate of lime, (β) furnace-slags containing 32·4 per cent. lime, and (γ) Portland cement, with carbonic acid as well as with carbonate of ammonia, and got from these carbonate of lime in the following percentages:—

	With Carbonic Acid.		With Carbonate Ammonia.
From (α)	4·65	....	7·72
" (β)	3·95	....	4·57
" (γ)	25·4	....	31·7

9. These results militate against No. 8. The carbonic acid and the carbonate of ammonia act upon the lime silicates much slower than upon the Portland cement; and so little carbonate of lime is formed that no separation of silica (or acid silicates) from the Portland cement, in consequence of the treatment with carbonic acid, can take place. The experiment proves, however, by the energetic formation of carbonate of lime, the existence of free lime, which combines during the hardening with the silicates, which during the burning of the cement have taken up some lime, without being fully combined with it.

(α) *Winkler* slaked completely hydraulic-lime from Strehlen, near Dresden, in boiling water, and burnt it afterwards again at a perfect white heat. The product was equal to the Portland cement.

10. Through the slaking with boiling water all silicic acid is therefore combined with the lime, and as the burning certainly does not dissolve this combination, so the hardening cannot originate from a combination of the lime and the silica. (*Winkler.*)

11. *Feichtinger*, however, finds that by treating a hydraulic lime with boiling water during several hours, all the free silicic acid cannot combine with the lime; that only happens when the lime has gone into solution, from which then the silicic acid takes the base, in consequence of which the water again dissolves more lime, and so on, till the silicic acid is saturated. But the lime is less soluble in hot than in cold water, the combination therefore of the lime with the silicates will only take place slower—in fact, the hot water protects the silicates against the action of the lime; the latter, too, was not fully combined with the clay during the subsequent burning.

(e) According to *Winkler* fresh as well as hardened Portland cement dissolves completely in muriatic acid diluted with alcohol. The same takes place with all silicates, prepared in the dry way, and soluble in diluted acids. Silicate of lime, however, which is prepared from water glass and lime solution, produces with alcoholic muriatic acid insoluble silicic acid, as a slimy residue. The same takes place with all silicates prepared by solution.

12. This experiment shows the difference between hardened Portland cement and a lime silicate produced in the wet way, and makes, therefore, against the correctness of the theory of Fuchs. (*Winkler.*)

13. Against No. 12.—The Portland cement is not a real lime silicate,

such as those which have been used for the experiment (*e*), and which were prepared in the wet way. Double silicates may act in a different way. (*Feichtinger.*)

14. The experiments of *Winkler* still do not controvert the views of Fuchs in relation to the Portland cement. There is a difference between the latter and hydraulic limes in the quality and composition of its clay, and consequently, also, the transformations during the burning are different. If the silica be very predominant in the clay it will combine with the lime very easily during the burning, at a lower temperature and without coagulating; if, however, the silica in the clay be united with several bases a coagulation (induration or partial fusion) will take place, together with the decomposition through the high temperature, without the silica being saturated with the lime. Thus it is that the mass gets more coherent and compact, which is a peculiarity of the Portland cement. Differences in the composition of the clay, and difference of the temperature of calcination, require different treatment.

Fremy then has proved the incorrectness of the opinions of his countrymen *Vicat*, *Rivot*, and *Chatonay*, who founded the hardening upon a taking up of water into combination of the silica, lime, and lime silicates which are formed in the fire. He has shown that neither lime silicates nor alumina lime silicates (artificially prepared) harden in combination with water, but that the lime aluminate—

$$(Al_2\,O_3,\ C_a\,O;\ Al_2\,O_3,\ 2\,C_a\,O;\ Al_3\,O_3,\ 3\,CO)$$

formed by the heating (and especially at a very high temperature) gets hard in water by producing hydrates. These formations are, according to Fremy, of great importance for the hardening of the Portland cement; the connection between lime and alumina silicates, formed in the calcination, with free lime hydrate, which is produced out of the lime aluminate, if there is no free lime, have also great influence upon the hardening.

(*To be continued*).

NOTES ON THE COMPARISON OF GUNPOWDERS, AND OTHER COMPOUNDS USED FOR MINING PURPOSES.[*]

(*Translated for the Practical Mechanic's Journal.*)

It is perhaps desirable here to observe that in the work from which the accompanying notes have been translated, a comparison of the *mechanical* effects *only*, of the explosive compounds in most frequent use for mining purposes has been attempted. Other matters, equally essential in a practical point of view, such as their relative cost, and the comparative facility and safety with which they can be handled, have *not* been touched upon.

The subject is treated under five heads:—1st, The method of comparison; 2nd, The volume of gas produced; 3rd, The volume of heat produced; 4th, The temperature of combustion; 5th, General observations.

The chemical data have been taken from Regnault's "Cours de Chimie," and for obvious reasons it has been considered desirable to adhere to the metrical notation of the original notes.

I.—METHOD OF COMPARISON.

Let A represent the volume of gas produced by a certain quantity of gunpowder, the weight of which = 1, temperature = 0°, tension 0·76 metres = τ.

δ = density of powder.

a = co-efficient of gaseous expansion, which according to Regnault's experiments = $\frac{1}{274}$.

t = temperature of the gas. The absolute force of the powder may then be represented by

$$p = A\,\delta\,(1 + a\,t)\,\tau.$$

The quantity, t, is dependent on the amount of heat produced, which we will designate γ, and this heat is divided into the heat retained by the gaseous products of the explosion, on which the temperature of the latter depends, γ', and the heat imparted to the circumjacent soil, γ''. The first of these, γ', must be considered in calculating the *disruptive* power of the powder; to the second, γ'', is due its power of *disintegration*.

In order to compare these qualities in different kinds of powder we must institute a comparison between the tension of the gases at the temperature, t, produced, say, by a litre of powder, and the heat imparted to the surrounding earth, &c. Here we are met by a serious difficulty, for the values of the elements, γ and γ', vary with an infinity of circumstances—the conductability of the materials surrounding the powder, the power of radiation, &c. They vary likewise with the rapidity of combustion. The quicker powder is in its action, the less the period of combustion is prolonged, the less should be the amount of heat thus lost.

The Swedish engineer, Nobel, in his observations on nitro-glycerine, points out the three principal elements requiring consideration in an examination of the qualities of powder:—

a Gaseous expansion.
b Development of heat.
c Rapidity of explosion.

The last element must for the present be neglected, as the data bearing upon it are quite insufficient, and, moreover, it varies greatly with the degree of granulation, &c., of the powder. In the absence of exact data for γ' and γ'', we may admit as means of comparison—

1st. The disruptive power—the absolute force of the powder,

$$p = A\,\delta\,(1 + a\,t)\,\tau,$$

or more correctly a proportional quantity

$$X = A\,\delta\,(1 + a\,t),$$

expressed in atmospheres, the resistance of the powder-case *being neglected*, and *the total heat produced being regarded as communicated to the gases evolved by the combustion of the powder.*

2nd. The disintegrating power—the heat,

$$Y = \delta\,\gamma,$$

it being assumed that the whole of the *heat developed is expended mechanically on the materials surrounding the charge.*

In different works are given various data for the values of A, t, and g, obtained, some by analysis, some synthetically, while others are stated to be the results of experiment. We give the preference to those obtained by analysis, as they are free from the external influences which vitiate most of the data founded solely on experiment. In order to avoid the confusion and error which would result from employing different values for these co-efficients, we will adopt the methods of calculation used by M. Chandelon ("Memoires de la Société des Sciences," Liege, vol. vii.), and by M.M. Bunzen and Schischkoff, in Poggendorf's "Annalen," vol. cii.

We must confine our observations to the powders most commonly used for mining purposes, viz.:—*Cannon powder*, *blasting powder*, *pyroxyle*, and *nitro-glycerine*, to which we have added the "*poudre revolutionnaire*" of Bertholet, and the "*poudre saxifragine*" recently brought out in Belgium by Major Wynants.

II.—VOLUME OF GAS PRODUCED.

Taking the weight of a litre of atmospheric air, at a temperature of 0°, and at a tension of 0·76, as = 1·2932 grammes, it is easy to calculate the weight of a litre of the different gases produced by combustion from their respective densities.

	Densities.		Weight per Litre.		
Nitrogen, . . .	0·9713	……	1·2932 gr. ×	0·9713 =	1·2560
Oxygen, , . .	1·1056	……,	"	"	1·4298
Chlorine, . . .	2·4400	……	"	"	3·1454
Carbonic oxide, . .	0·9670	……	"	"	1·2505
Carbonic acid, . ,	1·5290	……	"	"	2·0558
Aqueous vapour, . .	0·6220	……	"	"	0·8044

1. *Cannon Powder.*—Density, $\delta = 0·836$.

CHEMICAL REACTION.

$$K\,O,\ Az\,O^5,\ +\ S\ +\ 3\,C = K\,S\ +\ Az\ +\ 3\,C\,O^2.$$

Composition.	Grains.
Salpetre, ...	748·52
Sulphur, ...	118·34
Charcoal, ...	133·14
	1000·00

Products of Combustion.	Grains.		Litres.
Sulph. of potass, .	408·28, solid		
Nitrogen, . .	103·55	or	82·44
Carbonic acid, .	488·17	"	237·11
	1000·00	=	319·55

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[*] "Science du Mineur," 1868. Murguardt, Bruxelles.

2. *Blasting Powder.*—Density, $\delta = 0{\cdot}796$.

CHEMICAL REACTION.

$$\mathrm{K\,O,\ Az\,O^5,} + 2\,\mathrm{S} + 4\,\mathrm{C} = \mathrm{K\,S^2} + \mathrm{Az} + 2\,\mathrm{C\,O^2} + 2\,\mathrm{C\,O}.$$

Composition.	Grains.	Products of Combustion.	Grains.		Litres.
Salpetre, ...	643 76	Bisulph. of potass,	425·93, solid		
Sulphur, ...	203·56	Nitrogen, . .	89·05	or	70·89
Charcoal, ...	152·68	Carbonic acid, .	279·90	“	135·95
		Carbonic oxide, .	178·12	“	142·44
	1000 00		1000·00	=	349·28

3. “*Poudre Revolutionnaire*” *of Bertholet.*—Density $= 0{\cdot}800$.

CHEMICAL REACTION.

$$\mathrm{K\,O,\ Ch\,O^5} + \mathrm{S} + 3\,\mathrm{C} = \mathrm{K\,S} + \mathrm{Ch} + 3\,\mathrm{C\,O^2}.$$

Composition.	Grains.	Products of Combustion.	Grains.		Litres.
Chlorate of potass, . .	782 95	Sulph. of potass,	352·41, solid		
Sulphur, ...	102·14	Chlorine, . .	226·25	or	131·54
Charcoal, ...	114·91	Carbonic acid, .	421·34	“	204·65
	1000·00		1000·00	=	336·19

4. *Saxifragine.*—Density $= 1{\cdot}24$.

CHEMICAL REACTION.

$$2\,\mathrm{Ba\,O,\ A_2\,O^5} + 2\,\mathrm{S} + 9\,\mathrm{C} = 2\,\mathrm{Ba\,S} + 2\,\mathrm{A_2} + 3\,\mathrm{C\,O^2} + 6\,\mathrm{C\,O}$$

The composition varies. That given below appears to afford the best results. The admixture of a little saltpetre renders the charcoal more readily inflammable, but the effect is so trifling that it may be neglected in the following calculations:—

Composition.	Grains.	Products of Combustion.	Grains.		Litres.
Nitrate of baryta, . .	752·36	Sulphide of barium,	487·45, solid		
Sulphur, ...	89·61	Nitrogen, . .	80·63	or	64·20
Charcoal, ...	153·19	Carbonic acid, .	190·05	“	92 45
		Carbonic oxide, .	241·87	“	193·42
	1000·00		1000·00	=	350·07

5. *Pyroxyle.*—Density 0·84, in cartridges 0·170, in barrels 0·34. The latter may be taken as the average density when employed in blasting.

CHEMICAL REACTION.

$$\mathrm{C^{24}\,H^{17}\,O^{17}}\ (5\ \mathrm{Az\,O^5}) = 5\,\mathrm{Az} + 17\,\mathrm{H\,O} + \mathrm{C\,O^2} + 23\,\mathrm{C\,O}.$$

Composition.	Grains	Products of Combustion.	Grains		Litres.
Carbon, ...	253·97	Nitrogen, . .	123·46	or	98 29
Hydrogen, ...	29·98	Aqueous vapour,	269·84	“	335·46
Nitrogen, ...	123·46	Carbonic acid, .	38·80	“	18·85
Oxygen, ...	592·59	Carbonic oxide, .	567 90	“	454·14
	1000·00		1000·00	=	906·74

6. *Nitro-glycerine.*—Density $= 1{\cdot}60$.

CHEMICAL REACTION.

$$\mathrm{C^6\,H^5\,O^3},\ 3\ (\mathrm{Az\,O^5}) = 3\,\mathrm{Az} + \mathrm{O} + 5\,\mathrm{H\,O} + 6\,\mathrm{C\,O^2}.$$

Composition.	Grains.	Products of Combustion.	Grains.		Litres.
Carbon, ...	158·58	Nitrogen, . .	185 02	or	190·49
Hydrogen, ...	22·02	Aqueous vapour,	198·24	“	246·44
Nitrogen, ...	185·05	Carbonic acid, .	581·50	“	282·44
Oxygen, ...	634·35	Oxygen, . .	35·24	“	24·64
	1000 00		1000·00	=	744·01

III.—HEAT EVOLVED.

According to the experiments of Favre and Silberman, one kilogramme of charcoal, in the course of transformation into carbonic acid, produces an amount of heat equal to 8086 calories—one calorie representing the amount of heat required to raise 1 kilogramme of water 1° in temperature—a kilogramme of charcoal in the course of transformation into carbonic oxide, in like manner, produces 2473 calories; and a kilogramme of hydrogen, in passing into water, produces 34,462 calories.

Cannon Powder.

Here we have to take account of the heat produced by the formation of the sulphate of potassium, and by that of the carbonic acid. The first being unknown we may neglect it. Now, 0·13314 kilogramme of charcoal, in passing into $\mathrm{C\,O^2}$, produces an amount of heat equal to

$$0{\cdot}13314 + 8086 = 1076{\cdot}57 \text{ calories.}$$

Blasting Powder.

0·07634 kilog. of charcoal, in passing into $\mathrm{C\,O^2}$, produces 617·29 calories.
0·07634 “ “ $\mathrm{C\,O}$ “ 188·79 “
0·15268 806·08

“*Poudre Revolutionnaire.*”

0·11491 kilog. of charcoal, in forming $\mathrm{C\,O_2}$, produces 92·916 calories.

Saxifragine.

0·05106 kilog. of charcoal, in forming $\mathrm{C\,O^2}$, produces 412·87 calories.
0·10213 “ “ $\mathrm{C\,O}$ “ 252·57 “
665 44

Pyroxyle.

0 01058 kilog. of charcoal, in forming $\mathrm{C\,O^2}$, produces 88·99 calories.
0·24339 “ “ $\mathrm{C\,O}$ “ 500·79 “
0·25397
0·02998 kilog. of hydrogen, in forming $\mathrm{H\,O}$, produces 1033·17 “
1622·95

It is probable that water exists ready formed in pyroxyle; the heat produced should therefore be reduced by 589·78 calories.

Nitro-glycerine.

0·15858 kilog. of charcoal, in forming $\mathrm{C\,O^2}$, produces 1282·28 calories.
0·02202 “ hydrogen, “ $\mathrm{H\,O}$ “ 788·85 “
2071·13

Admitting, as above, that a proportion of $\frac{3}{5}$ths of water exists ready formed in explosive oils, the last amount should be reduced to 1597·82 calories.

To calculate the heat resulting from the combustion of powder, we will take the *specific caloric* of the gaseous products of its combustion, as they appear in the data furnished by Regnault:—

Oxygen, ...	0·2182
Nitrogen, ...	0·2440
Chlorine, ...	0·1214
Carbonic acid, ...	0·2164
Carbonic oxide, ...	0·2479
Aqueous vapour, ...	0·4750

In order to determine the *specific caloric* of a body which has not been subjected to experiment, we may adopt the rule laid down by Petit and Dulong, and since generalized by Newman and Regnault:—“The *specific heats* of bodies are inversely proportionate to the atomic weights, in bodies possessing the same composition and a like chemical constitution.”

For example, experience has proved that sulphate of zinc (*Zn* S) has a specific heat $= 0{\cdot}12303$, while its atomic weight is:—

1 equivalent of *Zn* $= 406$
1 “ S $= 200$
606

From this we may obtain the specific caloric of sulphate of potassium by the above formula:—

$$\frac{606}{690} + 0{\cdot}12303 = 0{\cdot}1081$$

So, in like manner, that of bisulphate of potassium:—

$$= 0{\cdot}1233, \text{ and sulphide of barium} = 0{\cdot}0705$$

Cannon Powder.—To determine the specific heat of the mixture of gases resulting from the explosion of a kilogramme of cannon powder, we must remark, that to raise in temperature 1°—

0·40828 K S, we require	. . .	0·40828 + 0·1081 = 0·044	calories.
0·10356 A Z, "	. . .	0 10356 + 0·2440 = 0·025	"
0·48817 kilog. of C O², "	. . . .	0·106	"
Total,	. . . .	0·175	

The heat produced by 1 kilogramme of powder being equal to 1076·57 calories, as we have shown above, and since 0·175 calories are required to raise the temperature of this mixture of gases 1°, the temperature of combustion will be—

$$t = \frac{1076{\cdot}57}{0{\cdot}175} = 6140^\circ$$

In like manner the specific caloric and the temperatures of combustion of the other compounds may be ascertained to be as follows:—

Blasting Powder, ... Specific caloric = 0·183
$t = 4405^\circ$

Poudre Revolutionnaire, . . . Specific caloric = 0 156
$t = 5956^\circ$

Saxifragine, ... Specific caloric = 0·155
$t = 4293^\circ$

Pyroxyle, ... Specific caloric = 0·307

$$t = \frac{1622{\cdot}95}{0{\cdot}307} = 5286^\circ\text{, or } t = \frac{589{\cdot}78}{0{\cdot}307} = 1921^\circ$$

Nitro-glycerine, ... Specific caloric = 0·310

$$t = \frac{2071{\cdot}13}{0{\cdot}31} = 6681^\circ \surd\text{, or } t = \frac{1597{\cdot}82}{0{\cdot}31} = 5161^\circ$$

GENERAL OBSERVATIONS.

A *resumé* of the various data given above enables us to determine the relative values of X and Y in a litre of each of the above kinds of powder.

	Force of X in Atmospheres.	Y in Calories.
1. Cannon powder,	6253	900
2. Blasting "	4602	642
3. Poudre revolutionnaire,	6115	743
4. Saxifragine,	7232	825
5. Pyroxyle,	6292 or 2470	552 or 201
6. Nitro-glycerine,	38631 or 29960	3714 or 2557

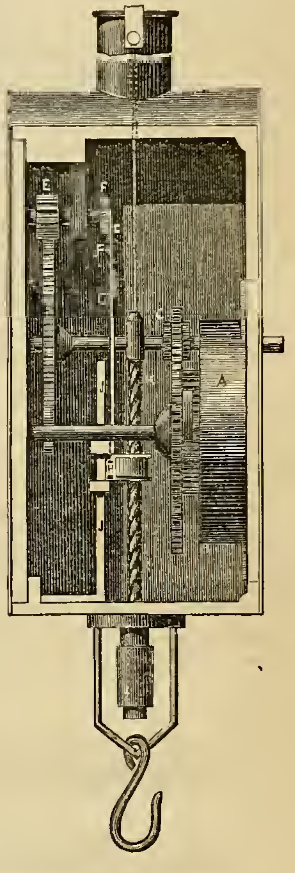
From this table, it appears that, for *equal powers of disintegration*, the powders arrange themselves in respect to their *disruptive qualities* in the following order, according to the values of the proportion, $\frac{X}{Y}$:—

1. Cannon powder,	$\frac{X}{Y} =$ 6·95
2. Blasting "	7·17
3. Poudre revolutionnaire,	8·23
4. Saxifragine,	8·74
4. Nitro-glycerine,	10·40 to 11·71
6. Pyroxyle,	11·39 to 12·28

Experiment has confirmed these results. It has shown that, in quarrying and blasting, pyroxyle and nitro-glycerine are very superior to ordinary powder, as they *heave* open the masses of rock without shattering them. It has also shown that the character (*brisante*) of "bursting" given to the poudre revolutionnaire of Bertholet has been fully recognized by artillerists. Lastly, it has proved, that although motives of economy in the manufacture, and, on some parts of the Continent at least, a desire to evade the heavy duties laid on powders of superior make, have been really the causes of the differing proportion of materials used in the composition of cannon and blasting powder, yet the proportions thus adopted as it were by chance for the latter, are in reality those best suited to the work it is required to perform.—H. M. C.

ROBINSON'S IMPROVEMENTS IN ROASTING JACKS.

This invention, which, from the lame and colloquial English employed in its title, might be taken for some improvements in the known methods of cooking by "roasting" the young pike fish or "jack," has for its object improvements in jacks used when roasting and baking. For these purposes a crank or its equivalent is applied to the last axis or wheel of an ordinary train used in constructing such jacks. To this crank or instrument a connecting rod is attached, which at its other end carries a screw nut, which with the connecting rod is guided by suitable guides in the to-and-fro motion communicated to the connecting rod; the screw nut is thus moved to and fro along a screw shaft or axis, by which such shaft or axis receives an alternating rotatory motion. To one end of the screw shaft or axis the ordinary suspending yarns are attached, and to the other end of the screw shaft or axis the ordinary suspending apparatus for the meat or other article is attached.



"In constructing a 25 lb. jack a spring box and spring, A, ½ inch wide, of the ordinary length, form, and strength is used; its arbor and ratchet are of the ordinary construction, and its main wheel differs only in size and number of teeth from those commonly used. The main wheel, B, is 2½ inches in diameter, and has sixty teeth; it is made to drive a pinion, C, of eight teeth, which on its axis carries with it a second spur wheel, D, 2¼ inches in diameter, and having fifty-four teeth. This second spur wheel, D, is made to drive a second pinion, E, of eight teeth, carrying a crank, F, which may be of any length of throw found desirable; but the most convenient size of crank is found to be from ⅝ to ¾ of an inch, giving a throw of ¼ to 1½ inch. From the crank, F, motion is by a connecting rod, G, communicated to a box, H, so constructed as on one side to carry a screw nut, and on the other to slide on a guide rod, J. The screw nut may be of any form, but the best consists of a piece of sheet metal about $\frac{3}{32}$nds of an inch thick or thereabouts, perforated with a hole in form corresponding to the section of the screw, K. The screw, K, may be of one or more threads, but a screw of two threads having three turns to the inch cut on a charcoal iron or steel wire, No. 8 size, on the wire gauge is found to answer well. The length of the screw is such as to allow the nut to traverse to the extent of the crank used, with an allowance for the stretching of the silk or other suspending line. Jacks to carry other weights are to be made in proportion to the construction above particularly described."

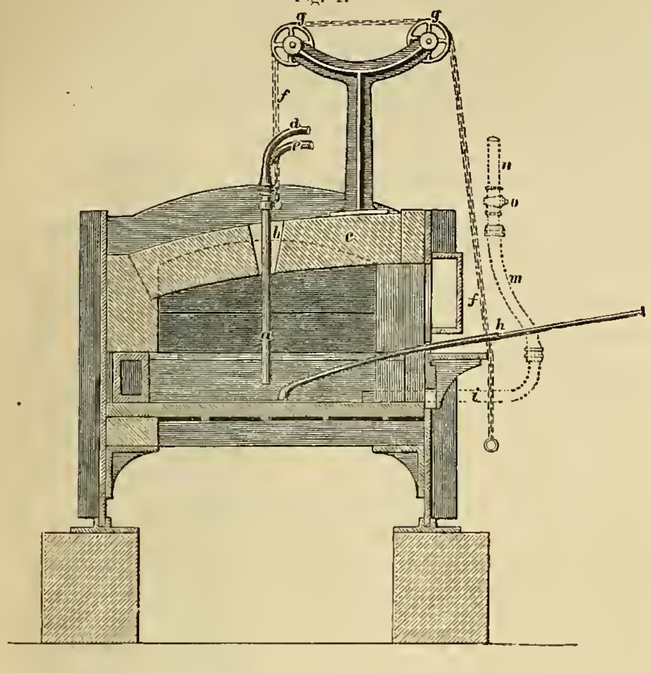
[Mr. Robinson is a sponge merchant of London, and amateur mechanic. We have personally examined his improved jack and seen it in operation, and can testify to its working well, and in our judgment presenting several points of advantage over the common bottle spring jack, which is that now most in use in Great Britain. A manufacturer who should take up this jack as a matter of trade would, we imagine, find it to answer.—Ed.]

THE RICHARDSON PROCESS.

Since our last paper on this process made its appearance several little improvements have been developed, just as is always the case in the bringing up of an important invention to maturity.

The drawback experienced by the workmen on account of the blowing out of the silicon sparks in a shower through the stopper hole against their bare arms, and in summer time bared bodies, has now been overcome by the employment of the hooded rabble shown at figs. 3, 4, and 5; and it is remarkable that at Parkhead, where the process has been in continual operation with a considerable number of furnaces for nearly a year, not a bad bar from the furnaces so working has been produced; whilst, as it is well known, in works where the iron is made by ordinary puddling only, bad bars are frequent.

Fig. 1.



At Messrs. Palmer & Co.'s works at Jarrow, the use of the tubular rabble has been supplanted by injecting the blast through a pipe introduced through openings, and as shown in figs. 1 and 2, the pipe being shown dotted; and the iron produced is of very excellent quality. At Parkhead an alternate admission of steam and air has been tried through a vertical central pipe, as shown at fig. 1.

The improvements that have been made are described in the specification of Messrs. Richardson & Beardmore's joint patent, as follows:—

Fig. 2.

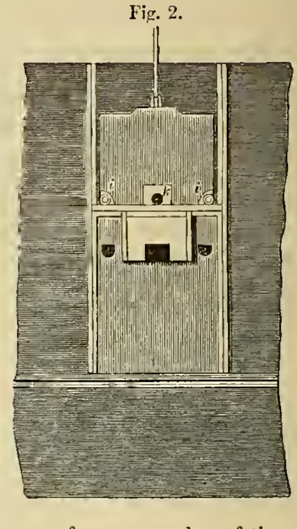
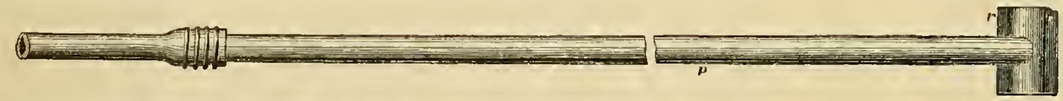


Fig. 1 is a transverse section of a puddling furnace, in which is shown the means of introducing air or other gases, as well as steam, into the charge of molten iron. This is effected by means of a pipe or tube, *a*, which is lowered into the molten metal through a hole or aperture, *b*, in the roof, *c*, of the furnace. The upper end of the pipe or tube, *a*, is formed into two branches, to each of which there is coupled a flexible pipe; one of the pipes, *d*, may be in communication with the steam space of a boiler, and the other pipe, *e*, with a compressed air or other gas receiver. Each of the pipes, *d*, *e*, is furnished with a stopcock not shown on the drawings, so that the supply of air, gas, or steam, may be cut off when necessary. By keeping open both cocks air or gas, and steam, may be injected into the molten metal at the same time, or one or other may be cut off, so that the air or gas, and steam, may be injected at the proper time, or for any number of times that the nature of the iron under treatment may require. Air or other gas, or gases, may be injected for the purpose of raising the temperature of the molten metal and freeing it from impurities; and when the temperature of the furnace is raised above what is required, steam may be introduced for the purpose of reducing the temperature, or steam may be injected first to desulphurize the iron, and air afterwards to decarburize the iron and increase the temperature of the furnace. The tube, *a*, is attached to a chain, *f*, passing over the wheels, *g*, *g*, and hangs in front of the puddling furnace, so that the depth of the pipe, *a*, in the metal, may be regulated by the puddler. The pipe, *a*, may also be moved about in the furnace; to allow of that being done, the aperture, *b*, in the roof is levelled towards the outside. During the time the air, steam, gas or gases, are being injected, the iron may be worked about with an ordinary puddling rabble, *h*, or a tubular rabble may be used to inject other gas or gases. Instead of injecting the air, steam, or other gases through a hole or holes in the roof, the pipes or tubes may be inserted through the door of the furnace, as shown at *i*, *i*, fig. 2, and the iron may be worked about by an ordinary solid or other puddling rabble inserted through the stopper hole of the door, as shown at K, fig. 2. Another method of introducing air or other gases, or steam, is shown in dotted lines in fig. 1, a pipe or pipes, *l*, is or are introduced through a hole or holes in front of the furnace on a level or thereabouts with the hearth. The pipe, *l*, is connected by a flexible tube, *m*, or a universal joint, to a pipe, *n*, leading to a steam boiler or other air or gas receiver. The distance which the pipe, *l*, is introduced into the furnace may be regulated by the puddler, and the supply of air or steam may be cut off by the stopcock, *o*. The pressure of the air or steam must also be sufficient to prevent the molten metal or cinder from running into the tube while in the furnace or during the time when the pipe, *l*, is being withdrawn and the hole plugged up. It is to be understood that while injecting air or steam by this method the charge is rabbled in the usual manner by an ordinary rabble, or a hollow rabble, such as shown in figs. 3, 4, and 5, may be used. This rabble is formed by a tube, *p*, bent at one end, which is screwed into or welded to a semicircular plate or shield, *r*, the ends being open, so that the air or steam may escape into the molten metal; or the blasts of air or steam may be introduced by any of the methods which have been patented or used in connection with the process known as the "Richardson process."—V. D.

Fig. 3.



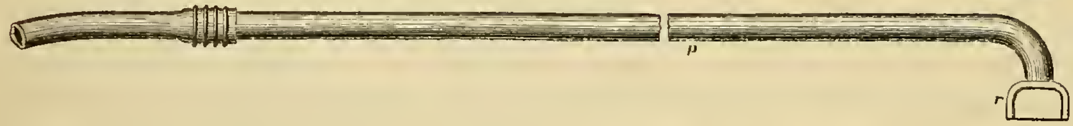
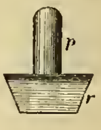


Fig. 4.

Fig. 5.



SELLERS AND CO.'S SMALLER PLANING MACHINE, WITH RACK AND SPIRAL PINION, AS EXHIBITED AT PARIS, 1867.

(*Illustrated by Plate* 6.)

(*Concluded from page* 83.)

Most conspicuous and important among the various novel features of this machine, is the manner of giving motion to the table; this is furnished with a rack, but instead of being operated by the ordinary spur gearing, it receives motion through a peculiar form of spiral pinion upon a driving shaft which crosses the bed diagonally, and passes out in the rear of the upright, on the side where the workman stands, as shown at figs. 1 and 2. This shaft is driven from the pulley shaft by means of a bevel wheel and pinion. The position of the pulley shaft places the driving belts within convenient reach of the operator; and its axis being parallel with the line of motion of the table, these machines may be placed parallel to lathes, and thus economize space and permit a better arrangement of workshops. By this simple driving arrangement a very smooth and uniform motion is imparted to the table; the pinion has four teeth, and is, in fact, a short piece of a coarse screw, the position of the teeth upon the same being as the threads of a screw of a steep pitch, and of a like number of threads to that of the teeth in the pinion. This pinion being placed upon the diagonal driving shaft, its action differs from that of an ordinary spur wheel, as it also does from that of a worm; that is to say, if the driving shaft were at right angles to the rack, the pinion would be the ordinary spur, but if it were inclined to the rack, say 5°, the teeth of the pinion would require to be slightly curved, and would commence driving at one side of the rack, shifting gradually to the other as it revolved. The same process takes place at any other angle, the sliding cross motion being more rapid the greater the angle from the perpendicular, until it reaches 90°, when it becomes a worm, and the teeth of the rack would then require to correspond with the angle of the thread. With the present arrangement, however, the teeth of the rack must be straight, but may be placed at any convenient angle to the line of the rack. Although the teeth of the latter are straight, and those of the pinion curved, the surface of contact and wear upon the rack is not limited to a small central portion of its teeth, but uniformly distributed over the whole width of the rack.

In the arrangement we are describing, the teeth of the rack are placed at an angle of 5° to its line of motion, to counterbalance any tendency the pinion might have to move the table sideways. The driving shaft revolves in bearings at both ends of the spiral pinion; these bearings are cast in the bed and connected by a trough surrounding the pinion, which trough is covered by caps under the rack, thus preventing chips and dust from reaching the pinion; the oil placed upon these bearings can escape only into this trough, and furnishes sufficient lubricating material for the pinion and rack.

It is a mistake to suppose this pinion must run in oil; in fact, such a condition of affairs would be highly injurious, as the oil would be thrown off by the revolution of the pinion, and would become a serious nuisance. The thrust upon the driving shaft from the motion of the table under-cut, is received against a step-bearing in front, and the lesser thrust during the quick return motion is received against hardened collars at the other side of the spiral pinion.

It will be noted that the sides of the bed directly between the uprights are very firmly braced by a box-shaped connection, the diagonal driving shaft not interfering with it, thus strengthening the most vital part of the machine, as is the case in most of the ordinary forms of planers; the same space being in some rack planers occupied by the gearing, while in the screw planer the height of the cross braces must be much diminished to give room for the screw and nut.

The disposition of the driving shaft and gearing in this machine may also be looked upon as an improvement over the frequently adopted plan of placing the driving gear and pulleys in front of the uprights, on the side of the machine opposite to the attendant; in which position these parts and the belts are apt to interfere with the planing of pieces overhanging on that side of the table, and are out of the reach of the operator. The transmission of motion to the table from a high speed of belt is accomplished by a single pair of bevels, the largest one of which may be easily made of such diameter, relative to the pinion, as to give the required reduction of speed and transmission of power without the intervention of other gearing. This arrangement has evident advantages over the ordinary screw planer, in which the gearing at the end of the screw is limited in size by the table projecting over the ends of the bed. The device for shifting the belts in the Sellers' planer is another peculiarity worthy of notice; it consists of a curiously shaped lever, vibrating horizontally upon a fulcrum pin placed between the fulcrums of the two belt shifters; the whole being supported upon an upward extension from the cap of the rear bearing of the pulley shaft, in the manner clearly shown at fig. 2 in the engravings. The middle arm is provided on opposite sides with an internal and external projection or tooth, these teeth meshing with corresponding notches and projections on the respective shifters; the teeth upon the middle lever are relatively so disposed that the motion of one shifter is effected and completed before that of the other is commenced, which arrangement combines, with the least possible lateral motion of the belt in shifting, the important advantage of entirely removing the one belt from the driving pulley before the other commences to take hold to reverse its motion. The shifting is thus effected with very little power, and the shrieking and undue straining of belts avoided.

The variation of stroke of the table is obtained by means of the usual adjustable stops on the side of the table, which stops actuate the above described shifting device by means of a double-armed lever and link connection. This lever and link are in the most convenient position for changing the position of the belts independent of the stops, so that the workman can with great facility control and reverse the motion of the table by hand in setting the tool or in planing over intervening irregular lengths; he can also set both belts on the loose pulleys, and thus, at any point, arrest the motion of the table without stopping the countershaft.

Several novel features are also introduced in the feed motion for the cutting tool, and in the devices for elevating the cutting tool during the return stroke of the table. The usual screw and central feed shaft are provided in the crosshead for transmitting either a horizontal or vertical feed motion to the planing tool in either direction; they receive a variable amount of motion for any required amount of feed through a ratchet wheel, fitted interchangeably to their squared end projections at the front end of the crosshead, where the ratchet wheel is actuated by a toothed segment, which receives at each end of the stroke the required alternate movements in opposite directions from a crank disc below by means of a light vertical feed rod, as shown at figs. 1, 3, and 4. The crank pin on the feed disc below is so arranged that its throw and amount of feed can be conveniently varied and adjusted during the cutting stroke of the table, while the machine is in motion. By means of an ingeniously contrived double pawl and ratchet wheel, deriving motion from a pinion on the front end of the pulley shaft, the crank plate is at each reversion of the stroke alternately moved a half revolution, and disengaged in either direction; friction is only employed to throw the pawl into gear at each change of motion, whereupon a positive motion of the crank disc is kept up by the ratchet wheel until the pawl is disengaged from the teeth of the ratchet wheel by a positive stop. In nearly all planing machines the feeding motion of the cutting tool is obtained from the belt-shifter, which is actuated by stops upon the table, as described; such an arrangement entails an undue amount of work upon these stops, whilst the variations of feed obtainable in this way are quite limited; besides which, under many circumstances, it will be found necessary to make the feed under the cut, as the feed motion will be always actuated at the end of the stroke before the motion of the table is reversed, whilst in a feed motion actuated from the gearing the motion will always be produced at the beginning of the stroke, and the amount of feed to be obtained in this way is practically unlimited. In nearly all modern planing machines the cutting tool is hung in what is called an apron, so adjusted as to allow the tool to swing loose on the back stroke of the planer table, but to be held rigidly when cutting. In large planers when the weight of the tool is great, and in all fine planing, this liberation of the tool is not sufficient of itself, but various arrangements have been added, whereby the tool point can be actually lifted clear of the work on the back stroke, and dropped into place ready for the cut after the article to be planed has passed under it; but perhaps none of these contrivances are so completely applicable as this one for lifting the tool in every position of the slide rest, and to do so from within the crosshead, without interfering with any of the machinery for working the feeds, which occupy the centre, about which the adjustable part of the saddle rotates.

The required end is attained in this machine in the following manner:—Into the saddle, sliding horizontally upon the crosshead, is recessed an angular space around the central part, containing the small feed bevels; a light plate wheel is placed into this space, with its bearing on the hub surrounding the centre bevels; gearing into this wheel is a small pinion, the shaft of which extends through the saddle, and has a cord wheel on the inside of the crosshead. In a spiral groove on the face of the plate wheel slides a block, which is attached to the end of a pipe surrounding the vertical feed screw, and extending upward through the casting in which it has its bearing; at its upper end this pipe carries a pair of elastic clamps, which operate by friction a flat rod passing the whole length of the vertical slide on its side next to the saddle; the lower end of this rod is thickened up, and has a hole mortised through it. In this hole the long arm of a bell-crank lever fits loosely, the short arm of this bell crank extending down immediately behind the tool apron, so that if the long arm be lowered it will push forward the tool apron, and when it is raised allow it to fall back in its place. Around the cord wheel, on the inside of the saddle, passes a cord which extends the whole length of the crosshead, guided over sheaves at each end; to one end of this cord is hung a weight, the other end being attached to a grooved segment, which is connected with the crank plate of the feed motion by a link, and thus made to impart a reciprocating motion to the cord, corresponding with the motions of the table, and occurring only at each end of the table movement, beginning with the reversion of each stroke. When the vertical slide is turned into any new position upon the horizontal axis of the saddle, the pin in the spiral slot will drag the plate wheel around, the cord wheel slipping within its encircling cord; and as soon as the machine is started, the parts at once adjust themselves to the new position, so that no matter what angle the vertical slide stands in with reference to the crosshead, the tool-lifting apparatus will work. The arrangement for effecting this are shown at figs. 5, 6, 7, and 8, and the detents for driving the ratchet gearing at figs. 9 to 14.

Planing machines of the above-described construction, made by Messrs. Wm. Sellers & Co., range in capacity for width and height from 20 inches to 6 feet square, with beds and tables of any required length. The machine exhibited at Paris was capable of planing a piece 25 inches square by 7 feet in length.

It is needless to descant to any of our practical readers upon the elegance and efficiency of the various novel contrivances employed in these planing machines—viz., that now described, and the greater one in Part 39. For ordinary planing work, the machine here described and illustrated is no doubt quite as good in every respect as that by any of our best British makers, and in some respects we deem it better. For some special purposes, particularly for planing up to a line or stop, or between limiting jaws or surfaces of any sort, we believe this machine will be found to surpass those on any design as yet prevalent in England. The greater machine, for capacity and adaptability, and this less one for its exactitude in performance, merit fully the praise we have bestowed upon them.—Ed.

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RECENT PATENTS.

TREATMENT OF JUTE.

James Baird, *of Croy.—Patent dated 21st September*, 1867.

This invention has for its object the dispensing, either wholly or partially, with the use of fish oils, such as whale, seal, or cod oil, which have hitherto been almost exclusively employed in the treatment or preparation of jute, for the purpose of softening the fibres thereof prior to its manufacture. These fish oils are not only in some cases expensive, but frequently their use is objectionable by reason of the excess of fibrinous or mucous matter which they contain, and which, though necessary to a certain extent, will, when in excess, tend to clog the fibres and the machinery operating thereon. According to one part of this invention, it is proposed to dispense entirely with the use of fish oils, and to employ in lieu thereof any of those fatty oils (such, for example, as olein, lard oil, rape oil, olive oil, cotton oil) which are free, or comparatively free, from dissolved fibrine, such fatty oils being either employed separately or in mixtures of any two or more of them. And in order to obtain the desired softening effect on the jute due to the presence of fibrinous or mucous matter in the fish oil, a fibrinous or gelatinous compound is applied to the jute (after the fatty oil or mixture of two or more fatty oils free, or nearly so, from dissolved fibrinous or mucous matter has been applied), specially prepared, which is to be mixed with the same quantity of water as is now used in the process of batching jute. This fibrinous or gelatinous compound may be prepared either from gelatine, blood, fibrine, albumen, caseine, or mixtures of one or more of them: gelatine is preferred. Should any one of these substances, or a mixture of them, be employed, it is to be dissolved in hot water to the consistency of syrup or a semi-fluid; and to this glycerine is to be added in any suitable proportion. This mixture or compound (which is called the "softener") is to be applied to the jute, mixed with the same proportion of water as is now used in batching jute, immediately after the fatty oil or mixture of fatty oils has been applied, when the jute will be found to be much softer and more flexible after being spun than when prepared from common fish oils alone.

In carrying out this first part of the invention, the fatty oil, or mixture of fatty oils, is applied by sprinkling or otherwise to the jute in the proportion of about 5 to 5½ lbs. of fatty oil or oils to an average bale of jute; but the invention is not restricted to this proportion. So soon as the oil is put upon the jute, the "softener" is applied, along with the water, after the manner of batching jute, or by any other suitable or convenient method. The proportions of gelatine, blood, fibrine, albumen, or caseine, or mixtures of one or more of them, and glycerine or their equivalents in the "softener," will depend very much upon the quality of the fatty oil or oils previously applied to the jute, and upon the nature of the jute or fibrous material to be operated upon. It is found that generally good results can be obtained by employing, after one or more of the fatty oils before referred to, a "softener" composed of 50 per cent. by weight of gelatine and 50 per cent. by weight of glycerine.

Another part of this invention relates to the preparation of an improved compound oil (which is called "jute oil") to be used as a substitute for pure fish oils in the treatment of jute, and consists in mixing any fatty oil, such as olein, lard oil, rape oil, olive oil, cotton oil, or other oil, or a mixture of any two or more fatty oils, which shall be free, or nearly free, from fibrinous or mucous matter, with any one or more of those fish oils which contain a greater excess of fibrine than is necessary for the due preparation of the jute. In this way an improved compound oil is obtained, containing just as much fibrine or mucus as will operate effectually upon the jute without clogging the machinery.

In carrying out this second part of the invention, the proportions in which the fatty oils, such as those before referred to, are to be employed in conjunction with the fish oils will depend upon the proportion of fibrinous or mucous matter contained in the latter. In proportion as the quantity is large or small, so is the addition of the oils free, or nearly so, from such matters increased or diminished. The proportions found to give good results have been about as follows:—Fish oil (containing 5 per cent. of precipitated fibrine in excess) 50 parts; oil free, or nearly free, from fibrinous or mucous matters, 50 parts: but these portions, as before mentioned, entirely depend upon the quality of the oil employed, and the fibrous materials to be operated upon. Good results have also been obtained by the use of a compound oil, or mixture of, say 75 per cent. of whale or seal oil with 25 per cent. of olein, and subsequently applying the "softener" before mentioned to the jute, which should, however, be used in a reduced or diluted state, so as to bring down the proportion of gelatine therein to about one-half the original proportion, whilst at the same time about 5 per cent. more glycerine should be added.

ARMOUR PLATES.

F. M. Smith, *of Waltham Abbey.—Patent dated 26th October*, 1867.

This invention has for its object the construction of non-laminated thoroughly welded armour plates, which shall consist, in fact, of homogeneous masses of soft wrought iron, thereby attaining the great desideratum that under the impact of shot these plates shall bulge with the least possible amount of cracking.

The ordinary system of manufacture, namely, by piling a number of thin plates one over another, heating them in the furnace, and then passing them between powerful rolls, or under the hammer, is open to the objection that a perfect weld between the component layers of plates cannot be guaranteed. Indeed, it is practically impossible to insure sound welding by piling and rolling together flat plates.

Now according to this invention it is proposed to construct an armour plate out of soft bar iron, in such a way that the only welds shall be between contiguous convex surfaces, so that on welding all "cinder" must necessarily be expelled. This is to be effected by forming the bar into a single or double coil similar to those used for Armstrong guns, welding it together as for a gun, cutting open the cylinder so formed, and flattening it out into the form of a plate either under the hammer or by passing it between rolls. By using a bar of soft iron and of a proper sectional form, absolutely sound welds may be guaranteed, and the resulting plate will therefore be a non-laminated, thoroughly welded, homogeneous mass of iron.

It is preferred to use a softer iron than that used for gun coils, as it is better adapted for armour plates. This will greatly increase the probability of sound welding, and in case a flaw in welding should occur, arising from "blister" or other like cause, such flaw will only present a short line on the surface of this finished plate, and consequently the chances of a pointed shot striking exactly in such a line would be very small indeed. But provided the adjacent surfaces of the coiled bar are sufficiently convex, there is nothing to prevent a practically sound and thorough weld being made. By using armour plates manufactured in the way proposed, for compound structures of two or more plates in thickness, such as shields for land defences, a considerable increase of strength or resistance may be obtained by placing two plates together in such a way that their respective lines of welding shall break joint or cross each other.

The iron best adapted for these improved armour plates would be the best and softest cold blast charcoal iron that can be procured; but good soft iron, such as is used in the manufacture of ordnance, will answer, if care be taken that the iron employed contains no trace of phosphorus, which would render it "cold short," and therefore unsuited to withstand the impact of shot.

PETROLEUM SHIPS.

J. H. Smith, *of Alleghany, and* E. G. Benedict, *of Southwest, U.S., A.—Patent dated 20th January*, 1868.

This invention consists in providing the hulls of ships and other vessels with a special compartment for containing oils and burning fluids, and in protecting the same with water, contained in a water chamber situate between two decks. The oil compartment is provided with pipes for supplying and discharging the oils and burning fluids, and for supplying the compartment with water or air, for the purpose either of raising the oils by hydrostatic or pneumatic pressure, or for supplying water to be used as water ballast.

Fig. 1 of the engravings is a longitudinal section of a ship provided with the said improvement. Fig. 2 is a transverse section of the same. The hull of the ship may be constructed in any of the known forms, and be provided with the ordinary appendages belonging thereto. The lower part or bottom of the hull is used as a compartment for receiving and holding oils and burning fluids in bulk. *m* and *n* represent two decks, which are made perfectly water-tight, and arranged with relation to each other so that a space, marked *h*, is left between them. On either side of the hull are openings, 5, which will allow water to flow freely into the space, *h*. A portion of the deck, *n*, is made arched, as indicated at D. The steam-boiler furnace rests on the deck, *m*, and is made of iron and "water-lined," as in the case of furnaces of locomotive boilers and the boiler furnaces of steam ships. 4 represents the steam boiler. The furnace and steam boiler may be made in any desired form. B represents a T-shaped pipe provided with a number of small branches, X, which enter small openings in one end of the furnace, such openings being arranged and provided with a flange, 2, as shown in fig. 1. On each side of the hull of the ship are other pipes and cocks, *c* and *c′*, which are connected to reservoirs, *g* and *f*; the pipes, *c* and *c′*, pass down through the decks, *m* and *n*, into the oil compartment. At the forward part of the upper deck of the ship there is another reservoir, *e*, to which is connected a pipe and cock, A; this pipe passes down through the decks, *m* and *n*, to the bottom of the hull of the ship. The T-shaped pipe, B, which conducts the oil to the boiler furnace, passes through the decks or floors, *m* and *n*, so that the lower end of the said pipe will pass through the deck, *n*, in the arched portion. A siphon-shaped pipe, *o*, is used for conducting water from between the decks, *m* and *n*, into the oil compartment, which is below the deck, *n*. The several cocks or valves on the pipes *c c′*, A B, and *o*, are marked 1 in the engravings. The reservoir, *e*, should be provided with a close cover. As the construction and arrangement of the several parts of the improvement will be readily understood from the foregoing description, and by reference to the accompanying engravings, the operation of the same may be described as follows:—The oil is conveyed into its compartment, at D, through the medium of the reservoir, *e*, and pipe, A, and when the compartment for the oil is filled, the valve or cock of the pipe, A, is closed; and should it be desired to force oil into the furnace, the valves or cocks, 1, of the pipes, B, *c c′*, and *o*, are opened, and water being introduced into the reservoirs, *f* and *g*, the oil will be forced up through the T pipe, B, and out at the outlets of the branch pipes, X, by the pressure of the water upon the oil, thereby supplying oil to the furnace of the steam boiler by hydrostatic pressure. It will readily be observed that by means of air pumps oil may be forced up to the furnace by pneumatic pressure, and it will also be observed that the oil may be forced or conveyed to any other desired locality from the oil compartment, D, either by hydrostatic or pneumatic pressure. When the oil is consumed as liquid fuel, or has been removed from the vessel, the valves or cocks of the oil and water, A, *c* and *c′*, respectively, are closed; and when it is desired to lighten the vessel the valve of the siphon pipe, *o*, is also closed, and water is pumped out of the oil compartment by any known means. When the ship is constructed with a compartment for holding water for ballasting the ship, the water compartment should be divided by a partition placed in the centre, running lengthwise, and the two compartments thus formed should be divided into two series of small compartments, by transverse partitions, with a small opening in each, so that the chamber of each compartment will communicate with each other. By thus dividing the water compartment into two parts, and then subdividing these two parts into smaller compartments, surging and sudden flowing of the water fore and aft, and from side to side, by the rocking and undulating motion of the ship, will be prevented. When the compartment is constructed for the purpose of ballasting the ship with water, one end of the siphon pipe, *o*, should pass through the side of the hull for conducting the water into the water compartment.

Fig. 1.

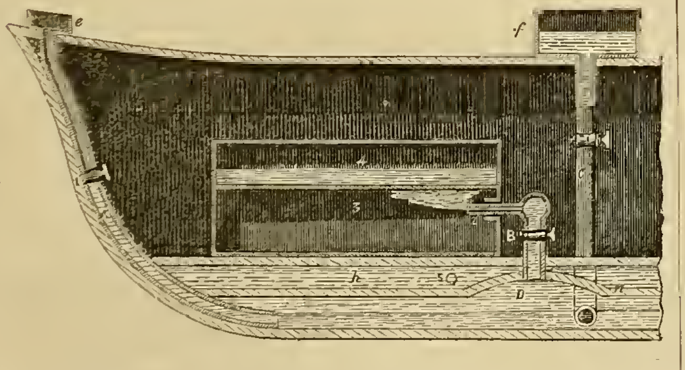
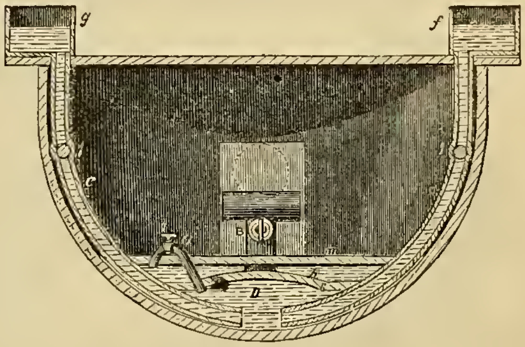


Fig. 2.



SEWING MACHINES.

Martin Samuelson, *of Hull.—Patent dated 15th October*, 1867.

This invention relates to that class of sewing machines wherein a reciprocating shuttle is employed, in conjunction with a vibrating eye-pointed needle, for producing what is known as the "lock stitch." According to one mode of carrying out the invention, it is proposed to actuate the shuttle by means of a rotatory crank pin in a disc on the end of the main shaft of the machine. This pin works in a vertical differential slot in an upright lever, vibrating on a fixed centre at its lower end. In order to give a quick motion to the shuttle whilst passing the needle, at a point where there is the least stress upon the crank pin or lever, the upper portion of the said slot is curved; and with a view to further facilitate the quick passage of the shuttle through the loop of the needle thread, the shuttle case or holder is set on the top of the lever at a slight angle. In the arrangements above described the shuttle will reciprocate in the arc of a circle, but if it be required that the shuttle should have a rectilinear reciprocating motion, then there is substituted for the vibrating slotted lever, above described, a plate sliding along two horizontal guide rods; such plate having a vertical differential or curved slot formed therein, in which works the crank pin, and being further provided with a shuttle case or holder at the upper end thereof. On rotating the said crank a to and fro horizontal motion will be imparted to the plate or shuttle carrier and shuttle, along the guide rods above referred to.

Fig. 1.

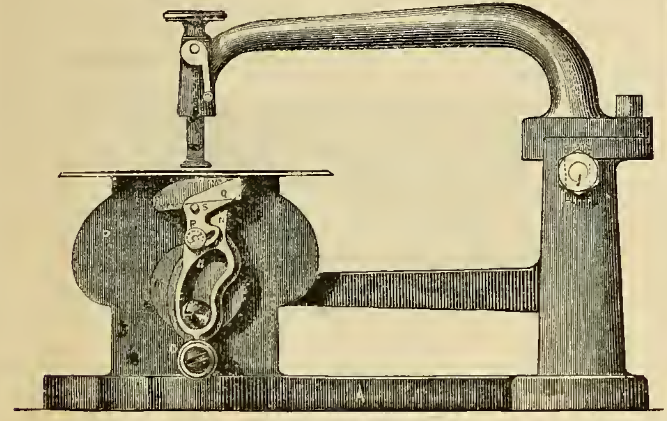


Fig. 1 of the engravings represents a side elevation of the improved sewing machine, looking on the shuttle case or holder. Figs. 2 and 3 are details of the shuttle carrier detached, and fig. 4 is a slightly modified arrangement of the shuttle carrier. A is the lever or main standard of the machine, carrying the driving shaft, in suitable bearings. On this shaft are keyed the driving pulley, D, and duplex cam, E, for producing the feed motion, all as heretofore constructed. On the back end of the driving shaft there is secured a crank pin, F, working in a differential slot in the end of the lever arm, G, connected to the rocking shaft, H, which vibrates between the adjustable centres, I I, and carries the needle arm, K, as is well known in this class or type of sewing machine. On the front end of the driving shaft is attached, according to this invention, a crank pin, L, carried by a crank arm or disc, M, the crank pin working in a vertically disposed differential slot, *a*, made in a vibrating shuttle carrier, N. Fig. 2 represents the inner face of the said shuttle carrier, and fig. 3 is a vertical section thereof at right angles to fig. 2. It vibrates on a fixed pivot or centre pin, O, at the lower extremity, and has a chamber or recess made at its upper or vibrating end for the reception of an ordinary sewing machine shuttle, *b*. The open or flat side of the shuttle works against the smooth face of the metal surface or plate, P, in lieu of traversing to and fro in a channel, groove, or shuttle race, and a vertical groove or slot should be made in the surface, P, for the needle to enter when it descends below the cloth plate, in order that the shuttle may pass freely through the loop of thread without being obstructed by the needle. In fig. 4 the shuttle carrier, N, is represented as sliding to and fro horizontally along the parallel guide rods, *c c*; or in lieu of guide rods, the upper and lower edges of the carrier, N, may slide in V or other suitably shaped guiding grooves. *a* is the differential slot in the shuttle carrier, L is the crank pin, and M the disc on the end of the main shaft which carries the crank pin.

Fig. 2.

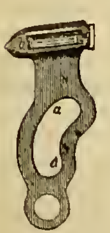


Fig. 3.

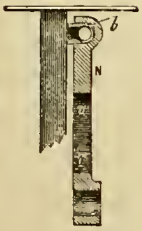
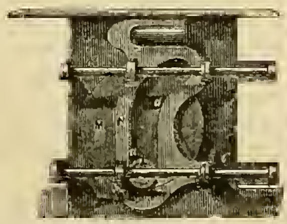


Fig. 4.



As the rest of the parts of the sewing machine are all well known, and form no portion of the invention, it is unnecessary to refer to them here; any mechanist acquainted with this class of machinery being competent to properly apply and adjust such parts.

TREATING SKINS.

J. L. Roessler, *Paris.—Patent dated 26th November*, 1867.

This invention relates to the treatment of rabbit, hare, and other skins, the fur of which is required to be utilized, and consists in substituting for the preparation of mercury, hitherto employed in the process known as "carrotting," of any hydrocarbonated or other substance capable of decomposing nitric acid into nitrous acid. As examples of those hydrocarbonated substances from which good results have been obtained, raw or refined sugar, gum, and starch, may be mentioned. By this means the process is rendered much less noxious to health, and more economical. The process of "carrotting," according to this invention, may be effected in two different ways, according to the quality of the skins operated upon and the strength of "carrot" to be obtained. According to one mode of treatment, the hydrocarbonated substance—such as raw or refined sugar, gum, or starch—and the nitric acid are applied to the skins separately; whereas, by the second method, a mixture of the two is brushed on to the skins. The skins are then dried in an oven, with a closed or an open fire, according as a white or yellow "carrot" is required. It may be observed here that skins treated according to this invention do not require to be dried at so elevated a temperature as those treated with mercury in the usual way. The proportions of the hydrocarbonated substance and nitric acid vary according to the strength and colour of the carrot required. For example, equal parts of nitric acid and hydrocarbonated substance may be used, or the mixture may be varied in the following proportions—$\frac{1}{5}$ to $\frac{1}{2}$ of hydrocarbonated substance and 1000 parts of water mixed with from $\frac{3}{10}$ to $\frac{6}{10}$ of nitric acid and 1000 parts of water.

FIRE-ARMS.

James Kerr, *London.—Patent dated 19th December*, 1867.

This invention relates to certain improvements in that class of breech-loading fire-arms constructed with a sliding plug or plunger, and known as piston and cylinder breech-loading guns; and consists, firstly, in applying to that construction of gun the ordinary gun-lock and hammer, so that all wet or dirt is prevented from getting into the action. In this improved arrangement no slots or holes for the lock action are required to be made in the cylinder, or in the plug or plunger.

Secondly, the invention relates to improvements in the striking pin of central-fire fire-arms of the before-mentioned construction, whereby a direct action in the sliding pin is obtained by the ordinary hammer and side lock, and consists in constructing the pin in one or more parts. When constructed in one part the entire pin works obliquely through the bolt; but when two parts are employed, one works horizontally in the plug or bolt, and the other obliquely, and bears at its lower end against the end of the horizontal pin, so that by the impact of the hammer on the oblique pin the firing of the gun is effected.

The invention relates, thirdly, to cartridge extractors employed with the above-mentioned class of gun, whereby the extractor remains stationary whilst turning the breech or bolt, for the purpose of locking or unlocking the same. This is effected by forming the extractor with a ring, or portion of ring or cross piece, which is free to turn on the closing plug or bolt; the extractor being prevented from turning with the plug by a recess or channel formed in the cylinder in which the plug slides, by which arrangement the necessity for cutting a recess in the rear of the barrel for the traverse of a fixed extractor turning with the plug is obviated.

Fig. 1.

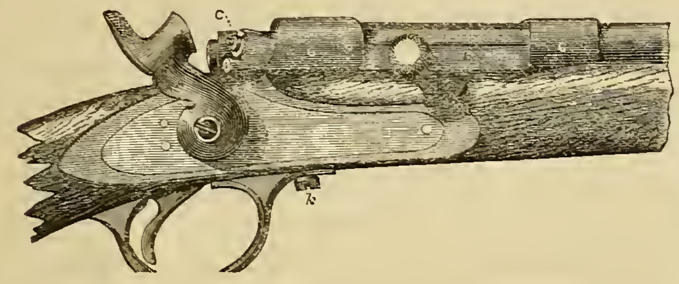


Fig. 2.

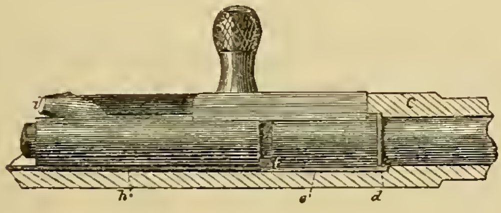


Fig. 3.

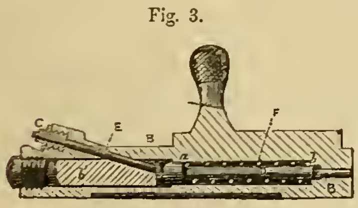


Fig. 1 of the drawings represents a side elevation of a portion of a gun with the improvements applied thereto; fig. 2 is a corresponding plan of the same; and fig. 3 is a longitudinal section of the sliding plug detached, showing the arrangement of the striking pin. A is the hammer of an ordinary gun-lock, which lock is fitted in the stock in the usual way; B is the closing plug, made to slide freely in the shoe, C (in this plug is arranged the striking pin or pins, D and E); the pin, D, is arranged to work horizontally in the plug, B, and may be provided with a spring, F, which bears at one end against the shoulder, *a*, formed on the pin, D, whilst the other end bears against the shoulder, *b*, formed in the closing plug. In the engraving (fig. 3) the shoulder, *b*, is shown as being formed in the metal of the plug, B, itself, which is bored from the rear end, and is then closed by a screw plug, *b′*; but if preferred the plug, B, may be bored from the front end and a bush be inserted, such bush being drilled for the passage of the striker, and forms at the same time the shoulder for the spring to bear against. In this modification the rear end of the plug, B, will be left solid. This spring, F, tends always to prevent the pin, D, from projecting beyond the end of the closing plug. The pin, E, is arranged to work in an oblique direction in the closing plug, and bears at its lower and inner end against the rear end of the pin, D, the upper end passing through the nipple, *c*, through which nipple it is made to project when the pressure of the hammer is removed by the action of the spring, F. When the plug, B, is closed, and is in a position for firing, as shown in fig. 1 of the drawings, the projecting end of the pin, E, will be in such a position as that when the hammer is released it will strike it, and by reason of the lower end thereof bearing against the end of the pin, D, such pin will be forced into or against the priming of the cartridge, and thus discharge the gun. *d* is an instrument for extracting the spent cartridge case from the barrel; it consists of a thin strip of steel, fitted into a longitudinal recess formed in the closing plug, B, and having one end secured thereto by a screw or otherwise. The free end of the strip, *e*, projects beyond the end of the plug, and is formed with a hook, which catches on to the metal rim of the cartridge, so that on withdrawing the closing plug, after having discharged the gun, the cartridge case will be drawn by it from the barrel, and may be entirely expelled by simply turning the gun over a little on one side. By rounding or curving and inclining slightly the front face of the breech, as shown at *e*, the plug, B, when being unlocked, tends to start or loosen the cartridge, should it be found to fit the chamber tightly. A recess is formed round the interior of the breech end of the barrel to enable the extractor to turn with the plug when locking and unlocking the same.

SPINNING MACHINERY.

JAMES EATON, *of Boston, U.S., A.—Patent dated* 31*st December*, 1867.

THIS invention relates, firstly, to improvements in the cop spindles of spinning machines, whereby greater facility is afforded for more readily slipping off the yarn from the tip of the spindle when "piecing up;" and, secondly, to improvements in the lubrication of the shafts of the driving drums of spinning machines. In carrying out the first part of this invention, it is proposed to form the end or tip of cop spindles of a slightly reduced diameter, the reduction extending a short distance down such spindle, and forming a shoulder thereon. The reduced part may be formed either concentric or eccentric with the axis of the spindle, and is provided with a helical slot or groove, in which the yarn enters and passes into a small central aperture, made vertically in the top of the spindle. Fig. 1 of the engravings is an enlarged view of a cop spindle, the upper end or tip of which is constructed according to the first part of this invention; the thread is here shown in the position it assumes when being spun. Fig. 2 is a plan of the tip of the spindle. Figs. 3 and 4 are similar views of a slightly modified form of spindle as hereinafter described. *a* is the main portion of the spindle; *b*, the cop; *c*, the thread; and *d* is the tip of the spindle, which, in lieu of tapering gradually into the body of the spindle itself, is of a slightly reduced diameter, so as to leave a shoulder between this reduced portion and the main part of the spindle. This reduced portion, *d*, of the spindle may either be made concentric with the axis of the spindle, as shown in figs. 1 and 2, or eccentric thereto, as shown in the modified form of spindle at figs. 3 and 4. In all other respects both spindles are precisely alike. A curved or helical slot or channel, *e*, is formed in each tip, *d*, such slot commencing at the cylindrical surface or periphery of the lower portion of the tip, *d*, and terminating in a central aperture, *f*, which aperture should coincide with the axial line of the spindle, whether the reduced tip, *d*, be made concentrically with or eccentrically to the said axis, as shown clearly by the respective plan views of the two arrangements, figs. 2 and 4. By having a projecting shoulder round the tip, *d*, the thread is much more readily disengaged from the curved slot when requisite.

Fig. 1.

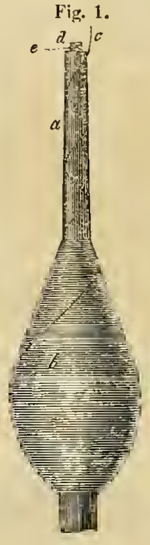


Fig. 2.

Fig. 3.

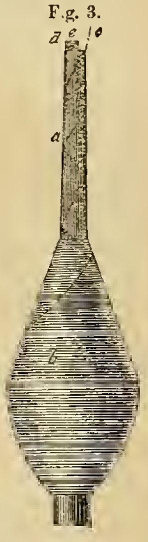


Fig. 4.

The second part of this invention, which has reference to a peculiar mode of applying oil or other lubricating liquid to the shafts of the driving drums of spinning machines, consists essentially in providing a recess or recesses of any convenient size and form in the brasses or bearings in which the journals of the shafts of the driving drums of spinning machines work, such recesses being filled with sponge or other suitable absorbent material, in such a way as to prevent waste of the lubricant absorbed thereby, and confine its action to the journals of the shaft against which such absorbent material bears.

OBTAINING ARTIFICIAL LIGHT.

JOSHUA KIDD, *Saint Paul's Wharf, London.—Patent dated* 15*th January*, 1868.

THIS invention consists, first, in effecting the increase of the illuminating power of a jet or flame of gas, or of hydrocarbon vapour, or of mixtures of the same, when used alone or in combination with atmospheric air, by causing such flame to issue from a finely perforated jet or burner, such as a "fishtail" or "bat's wing" burner, placed at an angle of 45° below a horizontal plane. Secondly, in causing the vapour of heavy oils or of hydrocarbons, which have a high boiling point, to be generated in boilers or stills or other vaporizing apparatus, and to issue therefrom under pressure, and then causing the vapour so escaping, and when ignited, to impinge upon a circular disc constructed of metal or fireclay, or other refractory material, such disc being placed at a regulated distance from the jet orifice. When employing such an arrangement, and when greater brilliancy is required, a stream of oxygen gas may be employed as a substitute for atmospheric air, and may be mixed with the before-mentioned hydrocarbon vapour when issuing from the jet or aperture, or when impinging upon the disc. Naphtha or light-burning oils may be used for the purposes of this invention; but the materials which have been found most suitable for the production of the before-mentioned hydrocarbon vapour, on account of their cheapness, are the heavy or dead oils of tar, creosote, naphthaline, heavy oils of petroleum or coal, and other similar fixed oils, which are now of small commercial value for the purposes of illumination. If desired, these heavy oils may be freed from solid carbonaceous matter by condensing the vapour generated in the retort. Oil thus prepared will not foul the vaporizer, and may be used for increasing the lighting properties of coal gas.

Fig. 1.

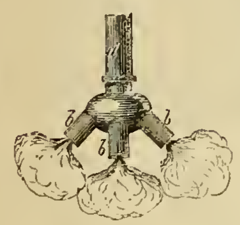


Fig. 1 of the engravings represents a sunlight gas burner constructed or arranged according to the first part of this invention, so as to direct the jet or jets downwards at an angle of about 45°. *a* is the gas pipe, and *b b* represent four or any other number of ordinary burners disposed round the end of the pipe at an angle of about 45° below a horizontal plane. By thus directing the flames from fine jets the too rapid admixture of the atmospheric air therewith is prevented, and hence a brighter light, free from smoke, is obtained.

Fig 2.

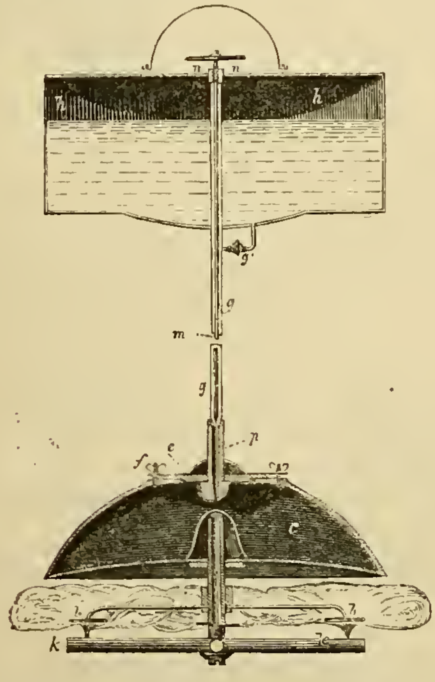


Fig. 2 represents another modification, suitable for ordinary outdoor purposes, detached from the vaporizing vessel. *h* is the oil reservoir, *g* the feed pipe leading by the branch, *g'*, from the bottom of the reservoir to the circular vaporizing vessel, *c*, which is heated by the flame from the burner or burners, as shown. The supply of oil to the vessel, *c*, is regulated by a screw spindle or rod, *m*, tapered or pointed at its lower end, which passes down the tube, *g*, the pointed end of the rod entering an orifice near the bottom of the tube. By turning the rod, its pointed end will be caused to enter into or withdraw from the supply orifice, and will thereby act as a regulator for adjusting the exact proper supply of oil to the vaporizing vessel, *c*. The oil from the pipe, *g*, is caused to fall upon coke or other porous matters, as shown at *p*. The vapour passes from the vessel, *c*, by the pipe, *i*, which carries the burners, *k k*, and above these burners are placed the deflecting buttons or discs, *l*, hereinbefore referred to, which spread the flame horizontally underneath the bottom of the vessel, *c*, as shown in the drawing. In this arrangement the deflecting buttons, *l l*, may be attached to the bottom of the vaporizing vessel itself. The deposit or residuum which forms in the vaporizing vessel, *c*, may be removed from time to time by unscrewing the cap or cover plate, *e*. *n* is the opening for supplying the oil to the reservoir, *h*. The vaporizers here described should first be heated sufficiently to vaporize the oil before it is allowed to enter the vaporizer in any convenient manner. Instead of the oil entering the vaporizers through the top, the oil pipe, *g*, may be bent so as to enable it to be connected with the vaporizer, *c*, through the bottom thereof. In cases where two vaporizers are fixed together this arrangement would be the best.

Fig. 3.

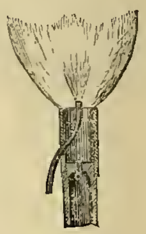


Fig. 3 represents an arrangement for burning oxygen gas in combination with hydrocarbon vapour or ordinary illuminating gas in an ordinary burner. The burner for the supply of the inflammable vapour or gas is provided with a small metallic open cylinder fitted on to the top of the burner, and through which the pipe for the supply of oxygen is introduced; the oxygen and vapour, or gas, mixing and burning together just above the top of the cylinder.

LAW REPORTS.

Electric Telegraphs.—Piggott *v.* the Anglo-American Telegraph Company, Limited. Before Vice-Chancellor Sir G. M. Giffard—August 1st and 3rd. This was a motion by the owners of Mr. William Peter Piggott's patent for "Improvements in the mode of generating currents, manufacturing submarine telegraph cables, and the mode of transmitting signals," that the defendants might be ordered to permit inspection by the plaintiffs of the method or process or apparatus or arrangement, by or according to which the defendants' cables are worked. The suit was instituted to restrain the alleged infringement of the patent by the defendants, who work the Atlantic cables between Valentia and Heart's Content. The patent is dated December 3, 1860, and the important parts of the specification were in these terms:—

"This invention has for its object improvements in the mode of obtaining or generating electric currents in combination with telegraph cables or wires. It has hitherto been the practice to generate the electric currents required for submarine cables by means of a battery or magnetic apparatus at the sending end, the galvanic or magnetic current evolved being of sufficient force to produce its effects on an instrument at the other end of the cable or receiving station. Now currents of electricity or magnetism, as is well known, in their passage through the wire excite within it a resistance, which increases according to a certain ratio between the distance and force. Thus, however well a cable or wire may preserve its insulation for a short distance, when the electric charge has to be augmented in order to reach a station more remote, the resistance consequent upon this increase of the force produces a leakage, and thence, sooner or later, the failure of the current to arrive at the distant station.

"My mode of remedying this defect consists in the novelty of so constructing the cable that it shall at all times retain a static electric charge, or in other words, so that a cable or the wire or wires of a telegraph cable may co-operate as agents with the generating surface, by which means such cable or wire or wires will be kept in a constant static condition, and consequently will require but very small power for the production of the required force."

The specification then, as the plaintiff alleged, described two particular cables as means of carrying out the invention; but as it was not alleged that the cable used by the defendants was similar to the cables thus described, it is unnecessary here to set out that part of the specification.

The specification concluded with a claim as follows:—

"What I claim as new is the method of giving a static charge to a cable and the means by which this is accomplished, as is set forth; and the manner in which I construct my generators, and which are equally capable of being used either on land or submerged in sea or other water for telegraphs, and which may be used for other purposes."

The plaintiffs alleged that previously to Mr. Piggott's invention the only known method by which signals could be transmitted by electricity or electro-magnetism, was by the use of a battery or electro-magnetic apparatus placed at one end of a proper insulated wire, which battery or apparatus generated an electrical current which was then forced from end to end of the said wire. The wire was under this system charged with electricity for each separate transmission of a signal. It is found that currents of electricity or magnetism, in passing through a wire, excite a resistance which increases according to a certain known ratio between the length of the wire through which the current is forced and the battery power. If, then, the wire were very long, as in the case of the wires in submarine telegraphic cables, it was found that in consequence of such resistance as aforesaid, a sensible time was occupied in the transmission of signals; and from this fact, and also from the necessity of separately charging and discharging the wire for each signal, it resulted that in such long wires the transmission of signals was of necessity very slow. Another disadvantage arising from the old system of telegraphic signalling was stated by the plaintiffs to be, that in order to overcome the above-mentioned retardation, caused as hereinbefore mentioned, it was necessary greatly to increase the battery power. It was, however, found that this very increase of power increased also the resistance before mentioned, so that if the distance to be reached were very remote, the resistance consequent on the increase of battery power produced a leakage, and thence a failure of the current to arrive at the distant station. And, in fact, according to the statement of the plaintiffs (though this was denied by the defendants), it was the impossibility of overcoming the resistance aforesaid, except by means which destroyed the capability of the wire for transmitting signals, which caused the destruction of the Atlantic telegraph cable which was laid across the Atlantic Ocean in the year 1857.

The plaintiffs insisted that by Mr. Piggott's invention these inconveniences are obviated, and that signals may by it be transmitted along wires of any length, and with much greater rapidity than by any known method, and with or without a small battery power, and all risk of leakage and consequent injury to the cable was thereby avoided.

The plaintiffs insisted that the invention of Mr. Piggott was new and useful, and that the great speed attained by the defendants' company in the transmission of signals was due entirely to the use of some method involving the principle of Mr. Piggott's invention, and they produced evidence to show that by no other means could such speed be attained. They brought evidence to show the use by the defendants of an alleged invention of Mr. Cromwell Fleetwood Varley, which they stated to be an infringement of Mr. Piggott's patent; and they insisted that they had made out a *primâ facie* case of infringement, and were entitled, almost as a matter of course, to the inspection asked.

The defendants denied that they had used Mr. Varley's process, or that they had ever employed Mr. Piggott's principle, and alleged that they worked their cables exclusively on the old system, that is, by generating the electric currents required for the cables by means of a battery at the sending end, the galvanic current evolved being of sufficient force to produce its effect on an instrument at the other or receiving end. The defendants also insisted that they had in their workings obtained knowledge of certain improvements in detail, and which were in the nature of trade secrets, and which it would be a great hardship if they were compelled to disclose. They also alleged that the plaintiffs' patent was invalid, on the ground of want of novelty, and that the use of the static charge was old. There was considerable conflict of testimony as to what had been actually done by the defendants, but in the view taken by the court of the construction of the patent, it became unnecessary to refer to that testimony in detail.

The defendants also set up Mr. Piggott's provisional, and alleged that it disclosed a different invention from that described in the complete specification, and that on that ground also the patent was bad. This provisional specification stated the invention to be "the manufacture of a cable composed of two or more copper wires as a centre or core, imbedded into or worked with tarred hemp or other fibrous material, which shall be covered with a coating of iron wire; and then by connecting the two inner or copper wires with a recording instrument at the receiving station, and bringing either end of the same in contact with the outer wires of the cable at the sending station, signals will be immediately transmitted."

Mr. Druce, Q C., and Mr. W. N. Lawson (instructed by Messrs. Birch and Ingram) appeared for the plaintiff; Sir Roundell Palmer, Q.C., Mr. Wickers, and Mr. Aston (instructed by Messrs. Bircham, Dalrymple, Drake, Bircham, and Burt), appeared for the defendants.

After hearing counsel for the plaintiffs the Vice-chancellor, without calling on the counsel for the defendants, said that in patent cases inspection was much more readily granted by courts of equity than by courts of law. It never had been treated as a matter of absolute right, nor had courts of equity ever considered themselves precluded from exercising reasonable discretion, regard being had to the circumstances of each peculiar case. In some cases, as in the sewing machine case, nothing was asked to be seen which is not openly exhibited to the whole world; in others, trade secrets were alleged; and although trade secrets would afford no ground whatever for refusing inspection if the ends of justice required that that inspection should be given, the court ought to be satisfied of two things, viz.; first, that there was a case really to be tried at the hearing, and secondly, that the inspection asked was of material importance to the plaintiff's case as made out by him. The inspection here asked was an inspection of what the defendants did in transmitting and receiving messages, and of the whole apparatus they use. The defendants said that there could be no such inspection without disclosure of the secret invention or secret inventions, the disclosure of which would subject them to great loss. The plaintiffs could have no difficulty in proving what the cable was which the defendants used, the material which it consists of, and how, when, and where it was manufactured. A part of the cable had, in fact, been produced and proved, and it was not even alleged that the cables were the same, and it is quite clear from the evidence that the cables were totally different, and that in point of fact the defendants used a cable with a single conductor.

His Honour then examined the provisional specification, stating that the essence of that beyond all question was the cable; and after going in detail through the complete specification, said that the invention appeared to be two descriptions of cable, and that the drawings described cables and nothing else. In that state of things, if the cables were totally different, and totally different they were, there would be no case to try at the hearing of the cause; and besides that, his Honour could not see that the discovery, always assuming the cables to be totally different, could be of the slightest importance to the plaintiffs. The plaintiffs had an opportunity of knowing what the defendants' cable was, this being well known to every one; and it being sworn and not denied that there had always been used a single conductor extending from end to end, and that there were trade secrets, his Honour thought he should be committing gross injustice if he ordered the inspection asked for, and refused the motion: costs to be costs in the cause.

KERR *v.* CLARK & CO—SCOTCH JURY TRIAL.—FIRST DIVISION, COURT OF SESSION.—Before the Lord President and a jury. The pursuer was Peter Kerr, thread manufacturer in Paisley, and the defenders were J. Clark & Co., thread manufacturers, Gordon's Loan, Paisley, and John Clark, thread manufacturer there, the sole partner of the said firm of J. Clark & Co. From the pursuer's statement of facts, it appears that on the 2nd October, 1857, he obtained letters patent under the Great Seal, and sealed the 5th January, 1858, for the invention of "Improvements in Preparing and finishing Threads or Yarns." By the said letters patent there was granted to the pursuer, for fourteen years from the date of the same, the exclusive privilege of making, using, and vending the said invention within the United Kingdom. At the date of the patent the invention was new; and the pursuer was the first and true inventor thereof. The patent was still in force, and the pursuer continued to hold the rights which were thereby created and secured. The pursuer further set forth that, in contravention of the said letters patent, the defenders, at their works in Paisley, during the period between the 20th April, 1867, and the date of raising the present action, had been wrongfully using the pursuer's invention, or a material part thereof, for the purpose of preparing, polishing, and finishing threads and yarns, and the pursuer has suffered loss and damage through the defenders' contravention of the patent. The defenders denied that the patent was valid. They alleged that the inventions described in the said letters patent, so far as they differed from machines or mechanism in common use long before the date, and at the date of the said letters patent, showed no ingenuity or invention, and are of no practical use. The alleged inventions described in the said letters patent, specifications, and drawings consist of mere colourable and useless modifications or alterations upon mechanism perfectly well known and in public use at and prior to the date of the said letters patent.

The following were the issues sent to the jury:—

It being admitted that the pursuer obtained the letters patent No. 9 of process, dated 2nd October, 1857, and sealed 5th January, 1858, and duly filed the specification of which No. 14 of process is a certified copy, and relative drawings of which No. 15 of process is a certified copy; and it being further admitted that, on 16th July, 1864, the pursuer duly executed, and thereafter, on the 18th August, 1864, duly filed a disclaimer and memorandum of alteration upon the said specification, of which No. 16 of process is a certified copy—

> "Whether, from the 20th April, 1867, to the 14th November, 1867, or during part of said period, and during the currency of the said letters patent, the defenders did, at their works at Paisley, wrongfully and in contravention of the said letters patent, use the invention described in the said letters patent, specification, and relative drawings, as altered by the said disclaimer and memorandum of alteration, or a material part of the said invention, to the loss, injury, and damage of the pursuer?"
>
> Or,
>
> "1. Whether the pursuer is not the first and true inventor of the invention described in the said letters patent and relative specification and drawings and disclaimer?
>
> "2. Whether the invention described in the said letters patent and relative specification and drawings and disclaimer was publicly used in the United Kingdom prior to the date of the said letters patent?"

Damages laid at £500.

The jury retired at twenty-five minutes to four in the afternoon, and, after an absence of an hour and a half, returned with a unanimous verdict for the pursuer upon the defender's first issue.

The Lord President said there were some other matters he would like to have the opinion of the jury upon. They would see that the patent was a patent for improvements in preparing and finishing threads or yarns; and he would like them to give their opinion as to what was meant by the word "preparing." His lordship then read the evidence upon this point, and asked the question—Whether, in the thread-manufacturing trade, "preparing" means starching or sizeing preparatory to the polishing? The jury could answer that question without retiring.

After a little conversation, the chancellor of the jury said that they had concluded that the word "preparing" meant dipping or saturating with size or other solution preparatory to polishing.

Mr. Clark wished to know if the word meant anything else than that, so far as the evidence went.

The Chancellor of the Jury—Nothing else.

The Lord President then put another question—Whether polishing threads or yarns by frictional contact with rollers or cylinders revolving on their own axis, in which grooves or angular indentations are made for the purpose of smoothing or polishing the said threads or yarns, was new at the date of the pursuer's patent?

The Chancellor of the Jury said that the jury wished to retire to consider that question.

The Lord President said he would give them another question to consider also—Whether the system or mode of constructing frictional polishers in which a current of air is made to pass through the shafts thereof, and to impinge on the threads or yarns by means of fanner-blades, was or was not new at the date of the pursuer's invention? The jury could consider these two questions, and also the amount of damages.

The jury again retired, and after an absence of half an hour, returned into court with the answer of "new" to both questions. They also unanimously found the pursuer entitled to damages to the extent of £50.

Counsel for the Pursuer—Mr. Clark and Mr. Balfour. Agents—Messrs. Gibson-Craig, Dalziel, and Brodies, W.S.

Counsel for the Defender—Mr. Young and Mr. Gifford. Agents—Messrs. Campbell and Smith, S.S.C.

REVIEWS OF NEW BOOKS.

FARADAY AS A DISCOVERER. By JOHN TYNDALL. 1 vol. 8vo. Longman, London. 1868.

GREAT as Faraday was, as a philosophic experimenter and discoverer, it has been truly said, that he was greater still as a man; a gentleman, in the highest, noblest, beautifullest sense in which that word can apply. And here we have, in very noble and beautiful manner, Tyndall, himself the bright and clear experimenter, teacher, and discoverer, a man in many ways with much of the mould of Faraday in his nature, anxiously striving that the outer world shall understand and recognize the glory that illumines the fame of the philosopher, with whom for many of his later years he was as a friend and trusted counsellor; but far more anxiously desirous that the beauty of life, conduct, and sentiment which hallow the remembrance of Faraday as a man, shall be appreciated, and that the noble lesson of his pure and transparent life shall not be lost to his countrymen and to the world.

With this twofold aim and object, Tyndall very ably and lucidly passes in review the grand career of Faraday's ascent of the portal steps of that fane of cosmical truth, upon which his eye was ever fixed with steady gaze, from the first days that his notes taken at Davy's lectures, had introduced him to the means of pursuing research. He well points out the sure and steady footfall with which Faraday made each ascent and advance, his caution, his intuition, his clearness in framing his question to nature, his exactness in interpreting her experimentally given answer.

We cannot pause, in a notice such as we are confined to here, upon the great results that Faraday achieved, and to trace to what further issues these have already led: the nature of magnetic rotations, the liquefaction of the gases, terrestrial magneto-electric induction, the grand generalization of the identification of the five electricities, the origin of power in the voltaic pile, the relations established between magnetism and light, the actions of magnetism on flame and gases, the discovery of diamagnetism and magne-crystallic action, and, finally, his *palpebra*, as Bacon would perhaps have called them, his grand but yet in some degree hazy and incomplete (so to him, and to every man as yet) generalizations and speculations, upon the nature and transference and lines of all force, and upon the nature of matter. These, which are but the larger stars in the firmament of Faraday's life labours, are told, and well told, and commented on here and there by Tyndall; but the subject is too vast to be handled in a volume of this small size, and we may express a hope that Tyndall will hereafter give us a larger volume, in which he may expand more commensurately to their importance, upon what Faraday has himself discovered, and show more elaborately to the world, in how great a degree Faraday has been the cause of discovery in others. Shall we not add, too, to show at large how great and various has been the fruit that has been gathered by others, in substantial "alleviations of man's estate," by the applications which have been made of the truths of which Faraday was the prophet? And how true a prophet! His was not the order of mind which is too characteristically prevalent in England, which no sooner learns a new truth, at first or at second hand (generally the latter, for nature does not love to tell her secrets to those who hunger and thirst, not after wisdom, but after the riches and honour that she has power over), than it runs off to make "science a shop for the greedy man," by seeking for a saleable application, a lucrative investment, for the new truth. Singularly disregardful of wealth, utterly disdainful of the frippery of titles—of such, at least, as are under our intelligent and well preserved *regime* shared by some few men of science of different mould, with soldiers, sailors, rich brewers, political toadies and adherents striving for name-handles, *per fas et nefas*, and provincial or other mayors and burgesses—Faraday lived and died a man of small means and simplest habits of life, owning no higher title than that which was in his case no unmeaning honour, but the expression of a fact, the Doctorate of natural laws, conferred upon him by the University of Oxford.

So also Faraday, with the power at his very hand, to have amassed wealth, probably great wealth, possibly riches fabulous in amount, had he bent the might of his insight and his energies towards discoveries that should have presented their first issues and ends in money-valued applications, *never* during his whole life seems to have once thought of making money, directly or indirectly, by means of philosophy. To be the clear and true interpreter of nature, to stand before her temple gates, and with clean hands and unruffled thought to proclaim the truths, by him experimentally revealed as the prophet of truth, to his fellow-men—such was Faraday's own notion of his part in this world's drama. The Royal Institution, with the modest endowment of his professor's chair, gave him the power to do this and to live, and therewith he was content. No career better could merit the parting expression, which might be an epitaph, with which Tyndall, to use his own words, "lays his poor garland upon Faraday's grave"—"Thou just and faithful knight of God."

Very beautiful is this little volume of Tyndall's in its other aim of which we have spoken—the homage rendered to, and the facts and reminiscences recorded in illustration of, Faraday *as a man*. It is a wiser and a higher than Achilles mourning at the sepulchre of a greater than Patroclus, but with all the generous fire of admiring friendship chastened by bereavement that characterized the Homeric hero. It would be vain here to attempt, by presenting specimens, to give any idea of this portion of the work; it must be read as a whole. Nowhere throughout those pages where Tyndall pours forth his heart in sympathy and eulogium, does he ever become maudlin or sentimental. The praise is as honest and real as its object was lofty and grand. It is summed up in the few parting words:—"And still this land of England contained no truer gentleman than he. Not half his greatness was incorporate in his science, for science could not reveal the bravery and delicacy of his heart." Those, and there are tens of thousands of such amongst the more educated in England alone, who have known little of Faraday, except his name famous as a household word amongst us, will find each one himself a little nobler and better than he was before, by seeing how and why these words of Tyndall's are true.

Such was Faraday, the philosopher and the gentleman, of nature's own moulding. One little point may bring his memory into yet nearer and more personal sympathy with many a reader of this journal. Faraday's father was a blacksmith; Faraday himself wrought for some time as a bookbinder. "I love a smith's shop, and anything relating to smithery," he wrote in 1841.

Faraday was born at Newington Butts in 1791, and died at Hampton Court, 25th August, 1867. All whom England owns of science, most of her men of art and of letters, and some of her aristocracy by patent and descent, fell into the ranks of those who conducted his honoured remains to their final resting-place; but as yet this nation has uttered no united voice of desire to honour his memory in any public manner. Had such and so great a man shed effulgence upon Germany or France, statues worthy of the hero would arise to show forth in those lands of higher culture, that they were not insensible to their possession of such citizens, nor disregardful of the noble lesson of such lives.—ED.

WORKMEN AND THEIR DIFFICULTIES. By MRS. BAYLY, author of "Ragged Homes, and how to Mend Them." Fifth thousand. Small 8vo. London: Nisbet & Co. 1851.

HERE is a little book, which we confess to never having heard of, except through an advertising column, until lately, and which we opened in the hope that in these days, when strikes and combinations and the intractability of the working men of Great Britain are said to be sending our trade abroad, and when the widening gulf between labour and capital seems to present a question to the legislator and to all, only second in importance to that of national education, we might, as we thought, find some new light, though from an unlooked-for quarter, upon the many still dark and difficult points of those complex questions. But we must confess we have been disappointed. A lady, however gifted, is scarcely the one to deal with matters demanding rougher and closer experience than she can have with rough-handed and too often hard-hearted labour, and more searching knowledge of employers and moneyed men's ways and evil doings, than are to be had by dinner or drawing room converse. In the home, be it ever so humble, we can well believe that a sensible, well informed woman with a lady's culture and with the moral worth that goes by the rather religious cant phrase of Christian virtues, may make a valuable and a practically good adviser. We can well believe that Mrs. Bayly might really know how to go about mending a ragged home, and be even at times as an angel in the house. But the difficulties of the workman at home, and his difficulties abroad—in the factory, upon the scaffold, in the cutting, before the furnace, in presence of the "ganger," the foreman, the timetaker, the pay-clerk, or face to face for once with his master—are widely different things; and the womanly charity and knowledge, that can deal perhaps efficiently with the one, are powerless from want of adequate information, perhaps too, from want of hard-headed logic, in the other. Even the intellect and genius of George Eliot, who has recently tried her hand at this sort of task, have proved insufficient to do more—shall we say it—than to add a little fresh confusion to subjects difficult to all before. Though we fail to find one single tangible point proposed for practice by either one or the other of these ladies, and to either masters or men, we do recognize this in both, that they intuitively see that better culture and discipline of heart, brought into use, on the part both of employers and employed, is the highway towards the wished-for plains of tranquillity and freedom from disputes.—Ed.

CORRESPONDENCE.

☞ **We do not hold ourselves responsible for the views or statements of Correspondents.**

(To the Editor of the Practical Mechanic's Journal.)

Sir,—In perusing your journal of July 1, I observe an article on "Sewing Machine Accessories," in which, from the entire absence of technicalities, and the concluding paragraph, the reader may be led into error and my own interests seriously affected, if not noticed by you in your next issue.

The hemmer described and illustrated in that article is "Morrison's Patent Archimedean Hemmer," advertised in your columns, and is supplied to Messrs. Willcox & Gibbs for the use of their machine, with the addition of an attachment plate of their own, which they consider more applicable to their machine than those usually supplied to all kinds of sewing machines by the sole makers, Messrs. Joseph Gillott & Sons.

I am, yours truly, the patentee for England and America,

JNO. MORRISON.

[We do not see in what way Mr. Morrison's interests can be "seriously affected" by the article in question. It is not our purpose in these papers to give the name of the inventor of each accessory, but solely to describe its construction and use. —E.P.A.]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

SOUTH WALES INSTITUTE OF ENGINEERS.

The general meeting was held at the Town Hall, Newport, on Thursday, the 6th ult., Mr. R. Bedlington, president, in the chair, and the following members being also present:—Messrs. M. Bates, W. Bevan, E. Brigden, T. Forster Brown, J. Brogden, T. Curnew, T. Ellis, jun., Christopher James, John James, Benjamin Jones, David Joseph, C. Kirby, M. Morgan, James Murphy, G. C. Pearce, E. Richards, D. Thomas, J. H. Edge (Edge & Son), J. James, &c.

The President expressed regret that owing to engagements on assize and other business, a number of members were unable to be present. This, however, had not been known in time to acquaint distant members of an alteration in the day of meeting, and so they had been compelled to abide by the first arrangement.

Mr. Brigden, secretary, read the minutes of the former meeting, which were confirmed.

Mr. W. T. Lewis was nominated vice-president, and Mr. John Cox was nominated for re-election. Messrs. C. James, D. Joseph, D. Thomas, H. M. Maynard, and W. Richards were nominated for re-election as members of the council, and Mr. Truron was nominated in the place of Mr. W. T. Lewis, nominated vice-president; Mr. Brigden was reappointed secretary.

Mr. J. Murphy objected on principle to the re-election of officers time after time, which excluded gentlemen who were well qualified from holding office.

The President said the matter had been considered by the council, whose object was to have the several districts represented at the board. It was open to any member to nominate gentlemen for office.

NEW MEMBERS.

Mr. David Evans, colliery manager, Cwmbach Colliery, Aberdare; Mr. J. Simpson, colliery manager, Rhoes Llantrissent Colliery, Caerphilly; Mr. Joseph Kay, mineral agent, Blaenavon; Mr. Herbert Blake, marine engineer, Newport; Mr. Evan Daniel, C.E., Christina Street, Swansea; Mr. W. H. M. Phillips, mineral agent, Edgehill Mines, Mitchel Dean; Mr. David Davis, colliery proprietor, Maes-y-ffynon, Aberdare; Mr. William Gray, colliery manager, Taibach; Mr. Wm. Bailey, engineer, Frampton Cotterell. Graduate: Mr. J. M. Johnson, mining engineer, Cinderford.

PRESIDENT'S ADDRESS.

The President said he had to thank them for the high honour they had done him in electing him president of the South Wales Institute of Engineers, an honour which he fully appreciated, and which he would do his utmost to deserve. They would be glad to know the Institute was progressing, both as regarded numbers and funds. The number of members was at the highest point it had ever reached, while their funds had reached a fair amount, and he hoped they would soon be in the position of having £1000 in hand, when it would be for the members generally to say what they would do with that amount. He, for one, would consider it well laid out in building some central building, which would serve as a place of meeting, and also as a museum of geological specimens of all kinds; but that was a matter which would come on in due course. The Institute was founded in October, 1857, and during the ten years he thought a fair amount of work had been done. A great number of papers had been read on a variety of subjects, and they had been thoroughly discussed. They had had papers on the South Wales district generally, and some parts had been especially described, as the port of Cardiff and the Aberdare coal-field, the port of Newport and its coal-field, the Caerphilly district, the Tillery coal seams, and the deep measures of South Wales. But it would be desirable to have papers on the Llantrissent, Rhondda, and Neath districts, and there might be other matters which required treatment, on all which they desired papers. Naturally they had paid attention to their own district, but they had been anxious for all the information they could get on other districts in England. Accordingly they had had papers on mining in Lancashire, on the districts of Leicestershire, South Staffordshire, East Worcestershire; the thin seams of Somersetshire had been described; they had had a paper on a portion of the Somersetshire coal-field, and one on the copper sandstone of Alderley Edge, in Cheshire. They had also had some papers in respect to Scotland and Ireland, so that other districts had received attention as well as their own. But they would find that some of the members had given them but little aid in the way of papers, and he put it to their conscience whether they had done their duty by the Institute in not doing so. They would remember that some little time ago there was a panic in the country as to the duration of the coal-fields, when it was thought that they were rapidly coming to an end. Several papers had been prepared as to the duration of the coal in this country, and an attempt had been made to get the probable duration of the South Wales coal-field. He believed there was diversity of opinion on that subject, and he invited further papers. Having coal in enormous quantities, as he doubted not they had, it was important that it should be worked on the best system. They had had papers on the long-work system, and the single and double stall system, and if any member thought those subjects had not been properly discussed they would be glad of further papers. Long work had made great progress in this district, far more so than he should have supposed likely in so short a time. The principal inducement to carry out that system was that they produced a large amount of marketable coal from a given area, in the best condition; and they had great improvements in ventilation. But the system had its disadvantages as well, and they wished further information from gentlemen who had adopted the system. They had had no complete paper on sinking pits, but they had had a paper on the difficulties encountered through sinking through a bed of quicksand, and the tubbing of shafts, and he asked the members whether in their wells they had adopted tubbing as much as was desirable? Then they had had a paper on the sinking of shafts by machinery, by a gentleman who had great experience in the sinking of wells for water. Of course the diameter of those was not very great, but he understood that in France and Belgium the system had been applied to shafts of considerable diameter. He asked for further information. One of the difficulties connected with mining had been what to do with the small coal. They had now before the Institute a paper on patent fuel, and he thought their closest attention would be required to see if small coal could not be used in the production of patent fuel. But it would be necessary for the manufacture to be carried on very economically, or the price of the fuel would nearly approach that of large coal. Machinery for winding and pumping had been treated, as also the subject of underground traction; but he conceived that further information was required. He thought it would be essential for them to pay greater attention to underground traction by machinery, the question of superseding horse labour being of growing importance, owing to the increased magnitude of the collieries. Whether the machinery should consist of tail ropes, endless ropes, or endless chains, was of course a subject of debate, and he invited information. Then a very important question was that of coal-cutting by machinery, in which he did not think they had yet been successful. There were a variety of machines which would do a given work, but they must consider that that work has hitherto been principally what was called the holing of coal, which was but a small portion of the collier's work. A very important question in connection with the winding had been the application of a powerful brake, and they had had two papers; but further information was desirable, the subject being of vast importance. He was sorry to see by the Blue-books, published annually in the shape of the inspector's report, that there were a great number of cases of over-winding in England, but he was happy to say that Wales had been pretty free hitherto from such accidents. Then, owing perhaps to the great depths to which the pits reached, and the great pressure causing a great amount of gas to exude from the veins, and making the collieries more explosive, ventilation was one of the most important subjects to which they could apply themselves. It was therefore proper to have before them the question of machinery as applied to ventilation. This had been done in a paper on mechanical ventilation, which had for several times been discussed, and would be still further discussed. They were told that the furnace was to be superseded by mechanical ventilation. If that were so, they should go fully into the merits of the various modes of ventilation, as Guibal's fan, which was before them in Mr. Pearce's paper. He hoped also they would have brought forward Lemiele's, Struve's aerometer, and Nixon's ventilator, and that they would have valuable information, and that without prejudice the members would be prepared to adopt the best mode. An important paper, which had evoked considerable discussion, had been contributed by a member on the subject of accidents in mines. It had been stated that South Wales had a greater amount of accidents than they had for the same amount of work in the north of England. He thought it desirable to reopen the subject, because he did not consider that a calculation should be based on the number of tons per accident, but the percentage of lives lost according to the number of men employed. Curiously enough they had had only one paper on the subject of safety lamps, and further information was invited. The question of the best result to be derived from the use of the coal needed ventilation, because, as they were told by chemists, they did not now gain the best results from the fuel used. The subject had not been lost sight of by the Institute; but he thought they would agree with him that there was not sufficient economy displayed in the use of coal in Wales, and therefore it was desirable the subject should be further treated. Their engineers should, too, he thought, give attention to the form of boiler, and the better consumption of smoke. Passing from collieries to ironworks, they had had but very few papers upon that important manufacture, and that was very curious, considering the number of ironworks represented in that Institute. They had had three papers on the blast furnace. In connection with that it was well known that in the north of England the altitude of the furnace had of late years been made much greater than in Wales; and one of the ironmasters in the Lancashire district had informed him that they derived great benefit from the increased height—that there was great economy in the consumption of fuel. If that were the case they invited additional information. Then they had had papers on the rolling of iron and on the blooming mill. They had also had papers on the manufacture of steel; but as there were extensive works in the district, the members generally would be glad if gentlemen connected with the works would furnish papers on the manufacture of steel in Wales. They had also had papers on tinplates and on the structure of iron, and some others of less importance. The beautiful structure, Crumlin Viaduct, had been ably described by Mr. Maynard, who had also supplied a paper on multiple drilling as applied to the drilling of the plates used at that bridge. The consumption of bricks had been great at the ironworks, and they had had papers on the manufacture of bricks. One advocated the utilization of ironstone tips, which had been used for the manufacture of common bricks. Another paper advocated the manufacture of stone bricks. Attempts had been made to utilize furnace slags, but hitherto not with much success. Although railways were the principal means for the transit of their minerals, they had not, it was curious to say, had a single paper thereon. The nearest approach was a paper on the manufacture of railway wheels; and it would be gratifying to know if there were any suggestions of improvement in railways. So desirous had the members been that there should not be anything in the way of refuse not utilized, that it had been suggested that iron pyrites or coal brasses should be used, and a paper had been written on the subject. When he mentioned that only one paper had been contributed on any remarkable appearance in collieries, he stated a very remarkable fact. One paper had been given them informing them of a metalliferous vein of lead passing through a coal-bed; but he thought gentlemen were not so unobservant underground but that they might have further papers on that topic. Well, as he had stated they had increased in numbers; but they had also to lament the death of three members during the past year, viz., Mr. Jno. Williams (Letty Shenkin), Mr. Gould (Cinderford), and Mr. W. Moyle (formerly engineer of the Rhymney Ironworks). In conclusion the president referred to some slight changes in the mode of conducting business, and sat down amid applause.

Mr. J. Murphy eulogized the address of the president, and expressed himself pleased with the suggestion of a building for the purposes of the Institute. He expressed his willingness to lay before the meeting the plan of a tram on an improved principle, as he thought, for carrying coal underground. He aimed at reducing the weight of the trams, which he believed would result in profit, and he thought also that Mr. Brogden had an idea of writing a paper on the subject. Mr. Murphy then suggested that in future they should give honorary premiums of books to writers of papers, and he trusted that would in future engage the attention of the committee.

MECHANICAL VENTILATION.

The discussion on Mr. G. C. Pearce's paper "On Mechanical Ventilation" was then resumed.

Mr. Bates proceeded to answer the question put at the last meeting as to the distance the air travelled at the Gethin pit, where Guibal's fan was used. They had six different splits, the total distance of the whole giving an average for each of 3430 yards, through which the wind travelled. Another question had been asked as to the quantity of wind that travelled in the workings of the mine compared with the quantity that went through the fan. When they had 100,800 cubic feet of air passing through the fan there were in the main returns 95,988 feet, and passing through the six splits 77,268 feet. Other experiments had been tried with similar results. Mr. Bassett had inquired how much per hour the quantity of wind was reduced for a certain number of hours after the machine stopped. He had measured for six consecutive hours. The first hour after the fan had stopped they had 21,120 cubic feet, the second hour 17,280 feet, and at that figure it continued to the end of the sixth hour, and he consequently attributed that 17,280 feet to natural ventilation. At the next meeting Mr. Lewis would probably be able to give them the result of experiments as to the temperature of the upcast and downcast shafts. During the experiments they had burned seven tons of coal in twenty-four hours—six of small, and one ton of large coal. Taking the first experiment, 100,800 cubic feet, that gave 8545 cubic feet per pound of coal.

The President said the first point was to get a machine which would give the largest amount of ventilation; and then would come, secondly, the question of economy. He thought mechanical ventilation was the cheapest, because they could use less coal and of commoner quality than was required for the furnace; but he thought they would not adopt mechanical ventilation unless they got a vastly increased amount of air.

Mr. Bates said the results of their experiments with the fan were now before the Institute, and it was for some gentleman to furnish them with furnace experiments, and compare the two.

The President remarked that when Mr. Bates had previously stated that the machine produced 100,000 to 120,000 cubic feet per minute, he was met by the question—"Well, that is a large amount, but it is not better than the furnaces are doing; and we want to know how far that air has to travel before we can know if the machine is doing good work—whether it travels one or two miles?"

Mr. Bates held that it made no difference; he gave them the result of the resistance, whether it were long or short. If it were a short distance, and they had a high water gauge, it told against themselves, because very likely they had bad windways. But if they measured the total resistance by the water gauge in both instances, he could not see that it mattered about the distance.

Mr. Brogden thought that it was important that the registers should be taken on the same basis, that they might be correctly compared, because he found it difficult to compare the returns of various gentlemen. The information would be much more valuable if it embraced not only the quantity of coal and the economic value, but the height of the shaft, the pressure of the water gauge at the bottom, and other things which necessarily affected the working of the fan. In their case they had found the advantage of the fan as being more economical than the furnace. But another important point was that gentlemen should give the size of the blade, upon which ventilation much depended.

The President said he thought Mr. Wilkinson would be able to give some valuable information—the result of experiments with the fan at Lower Dyffryn—at the next meeting.

Mr. M. Morgan inquired what was the power given out by the engine to produce 100,800 cubic feet?

Mr. Bates said, in the experiments to which he had just referred, with forty-six revolutions of the fan there were 12 lbs. of steam on the piston, which made the horse-power of the engine 37·80 or nearly 38, with that they got 100,800 cubic feet. The water gauge was an inch and a half, the horse-power in the air 23·82, which gave a decimal percentage of useful quality of 63.

Mr. Morgan thought, as to the 17,000 cubic feet which Mr. Bates put down to natural ventilation, it would be very satisfactory if the natural ventilation were tested before the fan were set to work.

The President remarked that the important point was to know whether colliers would have ample time to escape supposing the machine stopped. That was why it had been deemed necessary to make experiments as to the result of a stoppage. A great many who adopted the furnace were afraid of the effects of a sudden stoppage of the machinery; whereas, with the furnace, if the fire were put out, they would have a heated column for several hours.

In reply to some remarks by Mr. Morgan,

The President said one of the advantages of the fan over Struve's ventilator was its continuous action. It did not depend upon up-and-down strokes such as Mr. Morgan had described; but the fan ran equally throughout the time, and so gave equal ventilation throughout.

Mr. Morgan did not dispute that. He had only meant to say that with Struve's ventilator at Risca, which he had seen at the time of the explosion, it was of an impulsive character in consequence of its reciprocal motion.

After some further remarks the discussion was adjourned.

PATENT FUEL.

The President said the next business was the resumption of the discussion on Mr. Bassett's paper "On Patent Fuel." Mr. Bassett was unable to be present.

Mr. Brogden thought that to compare the relative merits of the different processes they should have the results given by engines from patent fuel manufactured by Barker's process and that manufactured by other means, and a comparative statement of the results of that manufactured from the steam coal of the district and that manufactured from the bituminous coal. He had made inquiries in districts of France where patent fuel was made, and he found that that which was intended for locomotive purposes was usually made with pitch, and so on, thereby at once precluding its use for household purposes. The bituminous coal was acknowledged to be more suitable for household purposes, and Barker's patent in London had been applied more to that perhaps than anything else; and perhaps for household purposes it might be necessary to adopt it to a certain extent where the others could not be applied. A knowledge of the relative cost of manufacture would be also interesting.

The President—Have you adopted any particular mode of manufacture?

Mr. Brogden answered in the negative. They were now discussing the question as to which was the best. They had manufactured some under Barker's patent, and he had stated several difficulties to Mr. Bassett, who thought they could be got rid of, such as the influence of the weather on exportation; and as they had always understood yet, Mr. Barker's did not answer so well as the others under exposure to weather.

The President—What do you allude to?

Mr. Brogden—I am not speaking of patents, but the usual manner of manufacture at Swansea—the pitch process. Mr. Bassett thinks it can be made to do so.

The discussion was then adjourned.

ASSURANCE OF COLLIERS AND MINERS.

Mr. Christopher James' paper on the insurance of the lives of colliers and miners urged an important subject on the consideration of the Institution and of the public generally. The writer stated that the men themselves are aware of the advantages of such combinations, which is proved by the support given to benefit societies and clubs; and these, if based upon correct data and honestly administered, are of vast good; but they are liable to the objections—Firstly, of being based upon unsound calculations of risk; secondly, that they only provide against the illness of the man, not for the support of his widow; and thirdly, that they are utterly incapable of affording adequate relief to the sufferers from a serious accident. He then asks why the men, assisted by coal-owners, should not contribute to a common fund, suggesting as a nucleus for it the "Surplus of the Hartley Explosion Relief Fund," which, as will be remembered, was divided between the different mining districts of England, to be used as seemed best to local committees. In several districts this remains untouched, that of South Wales being among the number.

He considered that such an association should have for its principal objects:—1. A guarantee sufficient to induce the men to contribute to it voluntarily. 2. The obtaining contributions from the employers and landlords in proportion to the magnitude of their works or the number of the men engaged in them, but in such a way that no misapprehension should arise in the minds either of the workmen or the public as to their being in any way personally liable for the support of widows, or for any larger sum than their usual quota. There should also be provision for receiving contributions or bequests from charitable persons, which the writer has little doubt would be often made were the association properly formed. 3. Simple and inexpensive machinery for the collection and payment of money. To be entitled to full confidence the association should—(1) Be managed by a committee elected at general meetings of masters, men, and donors to a certain amount; (2) should be based upon the calculations of risk made from the fullest data obtainable; and (3) should consist of a sufficiently large number of members to be able to bear among themselves the cost of the most fatal accident.

A RETURN SHOWING THE NUMBER OF MALE COAL MINERS EMPLOYED IN AND ABOUT THE COAL MINES OF GREAT BRITAIN, THE NUMBER OF FATAL ACCIDENTS AND LIVES LOST, THE QUANTITY OF COAL RAISED, AND THE PROPORTION OF ACCIDENTS AND LIVES LOST TO THE NUMBER OF PERSONS EMPLOYED AND THE TONS OF COAL RAISED.

Names of Districts.	Number of male coal miners employed as per census of 1861.	In the year 1866.								
		As computed by each Inspector for his own district.		Separate fatal accidents.	Lives lost by the accidents.	Persons employed per separate fatal accident.	Persons employed per life lost.	Tons of coal raised per separate fatal accident.	Tons of coal raised per life lost.	No. of collieries.
		Number of male persons employed.	Quantity of coal raised.							
Northumberland, Cumberland, and North Durham, .	22,719	25,647	10,763,800	91	99	281	259	118,283	108,725	160
South Durham, ...	30,805	35,720	14,930,000	84	115	425	310	117,738	129,826	155
North and East Lancashire, ...	23,525	25,440	6.774,000	58	69	438	368	116,793	98,173	265
West Lancashire and North Wales, . . .	24,302	30,000	8,000,000	105	150	285	200	79,023	55,666	180
Yorkshire, ...	31,938	35,500	9,450,000	61	425	582	83	154,918	22,235	434
Derby, Nottingham, Leicester, and Warwickshire, .	23,434	27,100	7,600,000	55	58	493	467	138,182	131,034	196
North Stafford, Cheshire, and Shropshire, . .	16,427	20,210	5,500,000	47	181	430	112	117,021	30,387	220
South Staffordshire and Worcestershire, . . .	25,235	27,000	10,300,000	96	109	281	248	107,292	94,495	544
Monmouth, Gloucester, Somerset, and Devonshire, .	21,762	26,000	6,000,000	75	81	346	321	80,000	74,074	223
South Wales, ...	26,292	29,200	9,376,443	113	120	258	243	82,977	78,137	338
Scattered over other counties, ...	148	—	—	—	—					
Totals (England and Wales), . . .	246,587	279.417	88,694,243	785	1407					
East Scotland, ...	18,091	21,200	6,100,000	29	32	731	662	210,348	190,625	254
West Scotland, ...	17,795	20,046	5,934,638	43	45	466	445	138,010	131,880	218
Totals (Scotland), ...	35,886	41,246	12,034,638	72	77					
Totals and averages (England, Wales, and Scotland),	282,473	320,663	100,728,881	857	1484	374	216	117,537	67,877	3192

The President thought that in such a district as this practical men should be able to agree upon some plan of assurance. He thought if some plan were agreed upon it would go a long way towards its enforcement by Act of Parliament. He believed what Mr. James advocated was, that there should be committees for certain districts, and that so much per ton should be charged upon the coal raised, and so much in the pound deducted from the wages of the men to supply a fund for the various districts.

Mr. James thought it the most advisable plan that the burden should be distributed between landlords, colliery proprietors, and workmen. The mode in which such assurance should be effected it was very difficult to determine.

The President—They were aware that there was a sick and doctor's fund at most of the various ironworks and collieries. Could not these be extended so as to form a fund for assurance? In large accidents there was a considerable amount contributed; but they were now speaking of single accidents, or where two or three lives were lost.

Mr. James believed it could be done, but it would be difficult; and he was of opinion that the burden, to give adequate relief, would be heavier than was generally thought.

Mr. Brogden, looking at the subject as a master, said it became a question how men who had invested large sums in works could assure themselves as well as the men. The interests of the two could never be severed. The writer of the paper admitted that men engaged in hazardous callings were paid higher wages, and to that extent the workman was enabled to lay by a certain sum, to which the employer contributed directly or indirectly. One difficulty was the possibility of causing jealousy on the part of the workmen, because his experience was that jealousy did arise when masters placed themselves in a position to handle the funds of the men; whereas they would find over and over again from the Trades' Commission that when the men had the operation of their own societies that jealousy was to some extent modified. If they had an assurance society he thought it should be a speculation apart from the government of the masters, and if the gentlemen who advocated some organization would place it on that ground and have their own officers, and do it on a large scale, it might answer; but he questioned if gentlemen connected with works on a large scale would be permitted to manage the funds without great jealousy on the part of the men—a result which they ought carefully to avoid.

The discussion was then adjourned.

Papers were then read:—By Mr. John King (communicated through Mr. Thomas Evans), "On King's Patent for the Prevention of Accidents in Pits;" by Mr. Morgan Morgan, "On the Brendon Hills Spathose Iron Ore and Mines." The discussions were adjourned. Specimens of the ore and diagrams, &c., illustrating the other subjects brought before the meeting, were exhibited.

THE MEETING OF THE BRITISH ASSOCIATION AT NORWICH.

THIS Association held its thirty-eighth annual meeting at the ancient city of Norwich, and on the 19th of August the president of the year, Dr. J. D. Hooker, delivered the inaugural address. Dr. Hooker is superintendent of the Royal Gardens, Kew, and has an eminent position amongst scientific botanists. It is not surprising, therefore, that the topics of his address have chiefly reference to botany. After some introductory matter, he referred to the action of the committee appointed by the Association to represent to the secretary of state for India the importance of adopting active measures to obtain reports on the physical form, manners, and customs of the indigenous populations of India, especially of those tribes that are in the habit of erecting monuments of stone. He then referred to the report of the committee appointed by the council of the Association, as to the government of the natural history collections of the British Museum, stating that the report had recommended that the superintendent should be freed from the control of the trustees, and should be placed in direct communication with the minister. He then proceeded to make remarks on museums as means of education. Much as has been written upon the uses of museums, I believe that the subject is still far from being exhausted; for in the present state of education in this country, these appear to me to afford the only means of efficiently teaching to schools the elements of zoology and physiology. I say in the present state of education, because I believe it will be many years before we have school masters and mistresses trained to teach these subjects, and many more years before either provincial or private schools will be supplied with such illustrative specimens as are essential for the teacher's purposes. Confining myself to the consideration of provincial and local museums and their requirements for educational purposes, each should contain a series of specimens illustrating the principal and some of the lesser divisions of the animal and vegetable kingdoms, so disposed in well-lighted cases as that an inquiring observer might learn therefrom the principles upon which animals and plants are classified, the relations of their organs to one another, and to those of their allies, the functions of those organs, and other matters relating to their habits, uses, and place in the economy of nature. Such an arrangement has not been carried out in any museum known to me, though partially attained in that at Ipswich; it requires some space, many pictorial illustrations, magnified views of the smaller organs and their structure, and copious legible descriptive labels; and it should not contain a single specimen more than is wanted. The other requirements of a provincial museum are—complete collections of the plants and animals of the province, which should be kept entirely apart from the instructional series, and from everything else. The curator of the museum should be able to give elementary demonstrations (not lectures, and quite apart from any powers of lecturing that he may possess) upon this classified series to schools and others, for which a fee should be charged and go to the support of the institution. And the museum might be available (under similar conditions of payment) for lectures and other demonstrations. Did such a museum exist in Norwich I am sure that there is not an intelligent schoolmaster in the city who would not see that his school profited by the demonstrator's offices, nor a parent who would grudge the trifling fee. You boast of a superb collection of birds of prey; how much would the value of this be enhanced could there be seen near to it such an illustration of the nature, habits, and affinities of the *raptores* as might well be obtained by an exhibition of the skeleton and dissected organs of one hawk and one owl, so laid out and ticketed that a schoolboy should see the structure of their beak, feet, wings, feathers, bones, and internal organs—should see why it is that hawks and owls are pre-eminent among birds for power of sight and of flight; for circling and for swooping; for rapacity, voracity, and tenacity of life—should see, in short, the affinities and special attributes of birds of prey. This, which refers to the teaching of natural history, is an operation altogether apart from training the mind to habits of exact observation, which, as is now fully admitted, is best attained in schools by Professor Henslow's method of teaching botany. Excellent manuals of many branches of zoology are now published, which are invaluable to the advanced student and demonstrator; but from which the schoolboy recoils, who would not refuse to accept objects and pictures as memory's pegs, on which to hang ideas, facts, and hard names. To schoolboys, skeletons have often a strange fascination, and upon the structure of these and the classification of the vertebrata much depends. What boy that had ever been shown their skulls would call a seal or porpoise a fish, or believe a hedgehog could milk cows, as I am told many boys in Norfolk and Suffolk, as elsewhere, do believe implicitly? A series of illustrated specimens, occupying some 5800 feet of wall-space, would give at a glance a connected and intelligible elementary view of the classification and structure of the whole animal kingdom; it would stand in the same relation to a complete museum and *systema Naturæ* as a chart on which the principal cities and coast-lines are clearly laid down does to a map crowded with undistinguishable details. Much of the utility of museums depends on two conditions often strangely overlooked—their situation and their lighting and interior arrangements. The provincial museum is too often huddled away, almost out of sight, in a dark, crowded, and dirty thoroughfare, where it pays dear for ground-rents, rates, and taxes, and cannot be extended; the object, apparently, being to catch country people on market days. Such localities are frequented by the town's people only when on business, and when they consequently have no time for sight-seeing. In the evening, or on holidays, when they could visit the museum, they naturally prefer the outskirts of the town to its centre. Hence, too, the country gentry scarcely know of the museum's existence; and I never remember to have heard of a provincial museum that was frequented by schools, but rather the contrary. I do not believe that this arises from indifference to knowledge on the part of the upper classes or of teachers, but to the generally uninstructive nature of the contents of these museums, and their uninviting exterior and interior. There are plenty of visitors of all classes to the museums at Kew, despite the outer attractions of the gardens, and I know no more pleasing sight than these present on a Sunday and Monday afternoon, when crowded by intelligent visitors, directing their children's attention to the ticketed objects in the cases. The museum should be in an open grassed square or park, planted with trees, or in the outskirts of the town, a main object being to secure cleanliness, a cheerful aspect, and space for extension. Now, vegetation is the best interceptor of dust, which is injurious to the specimen as well as unsightly; while a cheerful aspect and grass and trees will attract visitors, and especially families and schools. If the external accessories of provincial museums are bad, the internal are often worse; the rooms are usually lit by windows on one side only, so that the cases between the walls are dark, and those opposite the window reflect the light when viewed obliquely, and when viewed in front the visitor stands in his own light. For provincial museums, when space is an object, there is no better plan than rectangular long rooms, with opposite windows on each side, and buttress cases projecting into the room between each pair of windows. This arrangement combines economy of space with perfect illumination, and affords facilities for classification. Upon this plan the large museum in Kew is built, where the three principal rooms are 70 feet long by 25 feet wide, and each accommodates 1000 square feet of admirably lighted cases, 6700 feet of wall-room for pictures and for portraits of naturalists, besides two fireplaces, four entrances, and a well staircase, 11 feet each way. A circular building, with cases radiating from the wall between the windows, would probably be the best arrangement of all. A light spiral staircase in the centre would lead to the upper stories. Two or more of the bays might be converted into private rooms without disturbing the symmetry of the interior or intercepting the lighting of the cases. The proportions of the basement and first floor might be such as to admit of additional stories being added, and the roof be so constructed as to be removable without difficulty when an additional story was required; furthermore, rectangular galleries might be built, radiating from the central building, and lit by opposite windows, with buttress cases between each pair of windows. In respect of its natural history collections the position of the British Museum appears to me to be a disadvantageous one; it is surrounded by miles of streets, including some of the principal metropolitan thoroughfares, which pour clouds of dust and the product of coal combustion into its area day and night; and I know few more disappointing sights, to me, than its badly-lit interior presents on a hot and crowded public holiday, when whole families from London and its outskirts flock to the building. Then young and old may be seen gasping for fresh air in its galleries, with no alternative but the hotter and dustier streets to resort to. How different it would be were these collections removed to the townward end of one of the great parks! where spacious and well-lit galleries could be built, among trees, grass, and fountains; and where whole families need not any more be cooped up for the day in the building, but avail themselves of the fresh air and its accessories at the same time as they profit by the collection. Dr. Hooker then glanced at the progress of fossil botany during the last few years; and afterwards spoke in terms of high praise of Mr. Darwin's researches in the vegetable kingdom. The value of his discoveries, which add whole chapters to the principles of botany, is not, he said, theoretical only, already the horticulturist and agriculturist have begun to ponder over them, and to recognize in the failure of certain crops the operation of laws that Mr. Darwin first laid down. What Faraday's discoveries are to telegraphy Mr. Darwin's will assuredly prove to rural economy in its widest sense and most extended application. With respect to the theory of the origin of species from natural selection, the speaker said that so far from its being a thing of the past, it is an accepted doctrine with every philosophical naturalist, including, it will always be understood, a considerable proportion not prepared to admit that it accounts for all Mr. Darwin assigns to it. Of the many eminent naturalists who have accepted it, not one has been known to abandon it; it gains adherents steadily, and it is *par excellence* an avowed favourite with the rising schools of naturalists. Amongst the supporters of Darwin's views, Dr. Hooker alluded to Mr. Alfred Wallace and the veteran Sir Charles Lyell, who, after having devoted whole chapters of the first editions of his "Principles" to establishing the doctrine of special creations, abandons it on the tenth, and this, too, on the showing of a pupil; for in the dedication of his earliest work, the "Voyage of a Naturalist," to Sir C. Lyell, Mr. Darwin states that the chief part of whatever merit himself or his works possess has been derived from studying the "Principles of Geology." I know no brighter example of heroism, of its kind, than this, of an author thus abandoning, late in life, a theory which he had for forty years regarded as the very foundation of a work that had given him the highest position attainable among scientific writers. Well may he be proud of a superstructure, raised on the foundations of an insecure doctrine, when he finds that he can underpin it, substitute a new foundation, and, after all is finished, survey his edifice, not any more secure, but more harmonious in its proportions than it was before; for assuredly the biological chapters of the tenth edition of the "Principles" are more in harmony with the doctrine of slow changes in the history of our planet than were their counterparts in the former editions. Dr. Hooker made some remarks in reply to the anonymous author of an article in the *North British Review*, who, writing from the astronomer's point of view, had penned in many respects the cleverest critique of Darwin's work that the speaker had met with. He then turned to the question of the antiquity of man. A new science has dawned upon us—the early history of mankind. Prehistoric archæology (including, as it does, the origin of language and of art) is the latest to rise of a series of luminaries that have dispelled the mists of ages and replaced time-honoured traditions by scientific truths. Astronomy, if not the queen, yet the earliest of sciences, first snatched the torch from the hands of dogmatic teachers, tore up the letter and cherished the spirit of the law. Geology next followed, but not till centuries had elapsed, nor indeed till this our day, succeeded in divesting religious teaching of many cobwebs of scientific error. It has told us that animal and vegetable life preceded the appearance of man on the globe not by days, but by myriads of years. And, last of all, this new science proclaims man himself to have inhabited this earth for, perhaps, many thousands of years before the historic period. The following words conclude the president's address: —Let each pursue the search for truth—the archæologist into the physical, the religious teacher into the spiritual history and condition of mankind. It will be in vain that each regards the other's pursuits from afar, and, turning the object glass of his mind's telescope to his eye, is content when he sees how small the other looks. To search out the whence and whither of existence is an unquenchable instinct of the human mind; to satisfy it man in every age and in every country has adopted creeds that embrace the history of his past and future, and has eagerly accepted scientific truths that support the creeds. And but for this unquenchable instinct I firmly believe that neither religion nor science would have advanced so far as they have in the estimation of any people. Science has never in this search hindered the religious aspirations of good and earnest men, nor have pulpit cautions, which are but ill-disguised deterrents, ever turned inquiring minds from the revelations of science. A sea of time spreads its waters between that period to which the earliest traditions of our ancestors point, and that far earlier period when man first appeared upon the globe. For his track upon the sea man vainly questions his spiritual teachers. Along its hither shore, if not across it, science now offers to pilot him. Each fresh discovery concerning prehistoric man is as a pier built on some rock its tide has exposed, and from these piers will one day spring arches that will carry him further over its deeps. Science, it is true, may never sound the depths of that sea, may never buoy its shallows or span its narrowest creeks, but she will still build on every tide-washed rock, nor will she ever deem her mission fulfilled till she has sounded its profoundest depths and reached its further shore, or proved the one to be unfathomable and the other unattainable upon evidence not yet revealed to mankind. And if in this track one bears in mind that it is a common object of religion and science to seek to understand the infancy of his existence, that the laws of mind are not yet relegated to the teachers of physical science, and that the laws of matter are not within the religious teacher's province, these may then work together in harmony and goodwill. But if they would thus work in harmony both parties must beware how they fence with that most dangerous of all two-edged weapons, natural theology—a science falsely so called when, not content with trustfully accepting truths hostile to any presumptuous standard it may set up, it seeks to weigh the infinite in the balance of the finite, and shifts its ground to meet the requirements of every new fact that science establishes and every old error that science exposes. Thus pursued natural theology is to the scientific man a delusion, and to the religious man a snare, leading too often to disordered intellects and to atheism. One of our deepest thinkers, Mr. Herbert Spencer, has said: —"If religion and science are to be reconciled, the basis of the reconciliation must be this deepest, widest, and most certain of facts, that the power which the universe manifests to us is utterly inscrutable." The bond that unites the physical and spiritual history of man, and the forces which manifest themselves in the alternate victories of mind and of matter over the actions of the individual are, of all the subjects that physics and psychology have revealed to us, the most absorbing and perhaps inscrutable. In the investigation of these phenomena is wrapped up the past and the future, the whence and the whither of his existence.

MONTHLY NOTES.

Boots and Shoes.—Mr. A. Van Wagener, of Boston, has patented an invention for increasing the durability of the soles of boots and shoes, without materially increasing their weight. It consists in securing on to the under surface of the outer soles a number of thin and narrow steel plates or strips, placed transversely across the sole, and laid edge to edge, so as not to impair the flexibility of the sole. These steel plates are secured to the sole by steel or other metal nails, rivets, or fastenings. Fig. 1 of the engravings represents a plan of the underside of a boot or shoe sole with the present improvements applied thereto, and fig. 2 is a transverse section of the same taken along one of the metal strips: *a* is the outer sole of an ordinary boot or shoe, and *b b* are a number of thin and light steel strips secured transversely across the surface of the sole, and laid edge to edge, so as not to interfere with the flexibility of the sole. These strips are secured to the sole by steel-headed nails, pegs, or screws, *c c*, the heads of which are by preference made to project or stand out beyond the surface of the metal strips.

Fig. 2.

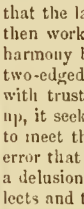
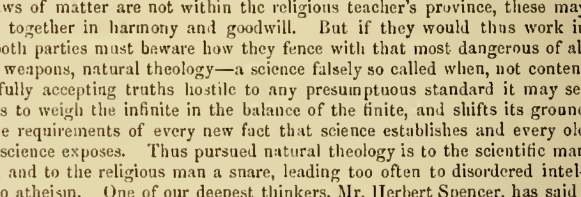


Fig. 1.



Mr. Wagener has also patented an improved mode of lacing boots and shoes, which is also applicable to the lacing of driving belts and other articles united by laces, the principal object to be obtained being to facilitate and expedite the operation of lacing, and to obtain a neater appearance in the laced article. According to this invention, as applied to a boot, it is proposed to secure, in any convenient manner, to the eyelet holes on each side metal loops, which may be either double or single, or both; in some cases a double loop may be used in combination with a single loop, the single loop entering between the two loops of the double one when drawn together. The lace is passed through the metal loops, so that on the loose ends being drawn tight, the opposite loops will be drawn and held together. Fig. 1 represents an elevation of a boot laced according to this invention, and figs. 2, 3, 4, and 5 of the engravings are enlarged details of the different forms of loops detached. *a a* are a series of metal loops or staples, which are so fixed to the two parts to be laced together as to overlap their edge; and *b* is the cord, lace, wire, or other locking device which is used in combination with the said metal loops or staples. The said loops or staples are composed of wire bent into the form of a loop, the ends of which terminate in flat annular washers, c c, the loop being at right angles to the washers. These loops are arranged in a line parallel to the edges of the two parts to be laced, and are fastened or secured in their places in any of the following modes:—The line along which the loops or staples, *a*, are to be fastened is determined by the size of such loops, which are designed to stand out from, or project over, the edge of the parts to be laced, and the annular washers are placed on that line, holes having been punched in the material at proper intervals. The loops are then made secure, either by inserting an ordinary metal eyelet, *d* (fig. 2), through the two annular washers and through the material and rivetting, or squeezing it down over the said washers; or by having an eyelet, *d*, formed upon or in one piece with one of the annular washers, and passing through the opposite washer, as shown in fig. 3; or, in lieu of the separate eyelet shown in fig. 2, a solid pin, *e*, may be passed through the two annular washers, and through the material, and rivetted over the washers, as shown in fig. 4; or, in lieu of a separate rivet, one end of the loop may be bent at right angles, as shown at *e′* in fig. 5, at a distance about equal to the thickness of the leather or other material to be laced, which end, so bent at right angles, will of itself form a rivet or fastening, which is passed through the annular washer, c, formed on the opposite prong of the loop, and then headed or rivetted down. The lace or cord, *b*, is then run through the loops, the ends crossing between each pair alternately. At the top of the boot one of the loops may be a double loop, as shown at *a′* (fig. 1), and the end of the lace, after passing through the lower eye of the double loop, may be passed in company with the other ends of the lace through the opposite single loop, and then brought back and passed up through the upper eye of the double loop, *a*; or the whole of the loops on one side of the boot may be double, the single loops on the opposite side entering between such double loops when the lace is drawn tight. Before putting on the boot, the parts to be laced are drawn apart simply, the lace yielding easily by slipping through the loops without becoming disengaged therefrom. When the boot is to be laced, all that is necessary is to pull on the two ends of the lace or cord, when it will assume an undulating line from the bottom to the top of the part to be laced, and will draw together and close the part to be laced; the top single loop entering between the two eyes of the double loop, *a′*, and being kept in that position by the end of the lace, which passes through the three eyes. The loose ends are then secured by tying in the usual manner.

Fig. 1.

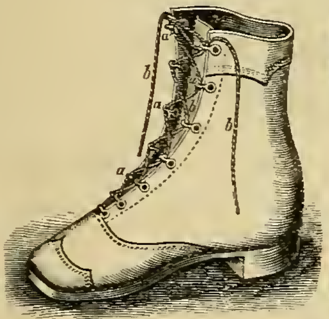


Fig. 2.

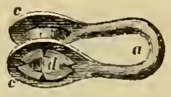


Fig. 3.

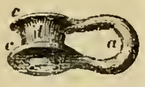


Fig. 4.

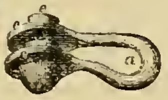
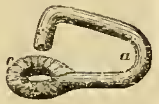


Fig. 5.



THE SUEZ CANAL.—The first works on hand at Port Said comprise two great béton jetties—the eastern and the western. The western, which is to have a total length of 2500 metres (a metre is, as nearly as possible, 40 inches English), is now completely executed for a distance of 2200 metres; and the eastern jetty, which will be 1900 metres in length, is now constructed for a distance of 1800 metres. Out of a total cubic measurement of 250,000 metres of blocks of béton, only 33,031 cubic metres remained to be made at the date of the last report, April 15, 1868, and only 57,882 cubic metres remained to be immersed. The making of the blocks is expected to be completed by August, and their immersion will probably be effected by December. One of the large steamers of the Messageries Impériales, plying on the coast of Syria, recently entered the harbour of Port Said, and came to an anchor in what is known as the Great Basin. Other steamers have also found a suitable anchorage in the interior port, where there is ample quay space for loading and unloading. Years ago it would not have been practicable for large sea-going steamers to have thus availed themselves of the shelter of Port Said; but contractors undertook some time since to dredge 4,669,943 cubic metres of "stuff" out of the channel and basins, and at the date of the last report they had actually raised 3,487,002 cubic metres. Seven dredgers, attended by hopper barges, are now at work in Port Said, and they extract 100,000 cubic metres monthly, a quantity which is expected to be increased to 120,000 cubic metres during the remainder of the summer. At this rate, the 1,182,941 cubic metres remaining to be extracted from the port will be all cleared out by May or June, 1869; and the seven dredgers now devoted to this work will then be moved on to the maritime canal. On the first division of this canal from Port Said to Lake Timsah, the contractor who was charged with some important excavations at El Guisr has completed his contract, which extended over 5½ miles, and comprised a cutting attaining at one point a maximum depth of 80 feet. Although 4,418,000 cubic metres had to be removed, the task was completed by January, 1868, six months before the time agreed on. Similar works have been completed across El Ferdane; they extend over 3¾ miles, and the total quantity of earth moved was 964,000 cubic metres. The attainment of these results has greatly facilitated the operations of the contractors who had undertaken to press forward the works between Port Said and Lake Timsah, a distance of 47 miles. Upon this length they had to dredge out 26,396,000 cubic metres of "stuff," and at the date of the last report they had actually removed 8,673,762 cubic metres, leaving the heavy total of 17,722,238 cubic metres still to be extracted. To complete this portion of the canal by the date now assigned for the commencement of public traffic through it (October 1, 1869), the monthly extraction must be carried to something more than 1,000,000 cubic metres, and great efforts are being made to secure this result. In January, 1868, the extraction effected on this portion of the canal was only 434,000 cubic metres; but in April the extraction had been increased to 668,000 cubic metres. This still left a considerable deficit, but of late the dredgers have been set to work by night as well as by day, and three additional dredgers will be brought into operation in the course of the summer. The seven dredgers now at work at Port Said will also be brought into operation next year between Port Said and Lake Timsah, and of course they will help to increase the amount of work done. At present there are thirty-one dredgers in going order between Port Said and Lake Timsah; but it will be seen by the arrangements contemplated that by the spring and summer of 1869 the number will be increased to forty-one. At one point (Ras-el-Ech) where it was said the nature of the earth would present insuperable obstacles, it is affirmed that the canal has been carried to its full depth of 26 feet 8 inches, while the slopes maintain themselves in a satisfactory manner. The third section of the canal extends from Lake Timsah to the Bitter Lakes, and is nearly 15 miles in length. Of this distance about 12 miles are being executed by dredgers, and the remaining 3 miles by hand labour. The total quantity of "stuff" to be removed in the two first portions is 8,428,991 cubic metres, and at the date of the last report 4,530,567 cubic metres had been actually moved, leaving 3,898,424 cubic metres still to be dredged. These figures relate, it should be added, to the passage of Lake Timsah, Toussoum, and Serapeum; the remaining 3 miles embrace the outlet of the canal into the Bitter Lakes, and involve the removal of 1,292,848 cubic metres of stuff, of which 692,512 cubic metres had been removed at the date of the last report. To complete the first and second divisions of the third section of the canal by October 1, 1869, it will be necessary to effect a monthly extraction of 210,000 cubic metres, dating from April, 1868, and as eleven dredgers have now been brought into working order, it is expected that the needful activity will not only be attained, but will even be exceeded. The last division comprises a dry excavation, on which 600,636 cubic metres remained to be removed at the date of the last report. As, however, 1500 men are now at work upon this division, and as the number can be increased if necessary, it is expected that this dry excavation will be completed before the end of the current year. The fourth section of the canal—that comprising the passage of the Bitter Lakes—is expected to prove the easiest of all, as with the exception of some salt deposits here and there, the lakes are about the depth of the canal for a good 16 miles, and on the waters of the Mediterranean being admitted, the available water way is expected to become still deeper, while it presents at many points a width approaching ¾ of a mile. On the Suez side of the Bitter Lakes it will be necessary to deepen the channel for some distance. The fifth and last section of the canal, from the Bitter Lakes to the roadstead of Suez, may be divided into two parts. The first part extends from the basin of the Bitter Lakes to the plain of Suez, 21¼ miles, and this is being executed by a dry excavation involving the removal of 10,100,000 cubic metres. There then remains a final distance of 8¾ miles, which is being executed by dredgers, the total quantity of earth to be removed being 7,019,000 cubic metres. At the date of the last report, 5,814,300 cubic metres remained to be removed on the dry excavation; and it was expected that the monthly extraction would be carried to 450,000 cubic metres. Should this anticipation be realized, the excavation will be completed by April, 1869. In April it was calculated that 5,300,000 cubic metres remained to be dredged on the last 8¾ miles, and in May the extraction effected was 186,000 cubic metres. Three new dredgers are about to be brought into operation, and it is expected that the extraction will be increased by degrees to 300,000 cubic metres per month, and even more with the help of nightwork and increased efficiency in managing the dredgers.—*Pall Mall Gazette.*

SAW TEETH.—Mr. Peter Cook, of Tanawanda, U.S., A., has invented certain improvements in the shape of the teeth of saws. The invention is patented in this country by Mr. T. A. Weston, of Birmingham, 11th December, 1867. Fig. 1 of the engravings represents a portion of a circular saw constructed with the improved teeth; fig. 2 is a portion of a straight saw with the same teeth; and fig. 3 is an enlarged transverse section showing the bevelling and set of the teeth. According to this invention the teeth, *a*, are of a rectangular, or nearly rectangular form, the tops of the said teeth being bevelled to form a cutting edge throughout their entire length, as shown in figs. 1 and 2. The cutting edge of each tooth coincides with the line of motion of the saw, and such cutting edge may be of equal length to its base or root. The bevel of each tooth is on the opposite side to the next one (see fig. 3), and the teeth may be set in the ordinary way; the set or deflection being on the opposite side to the bevel of the tooth. If desired, the ordinary clearing

FIG. 1.

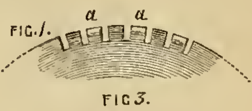


FIG 3.

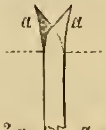
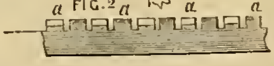
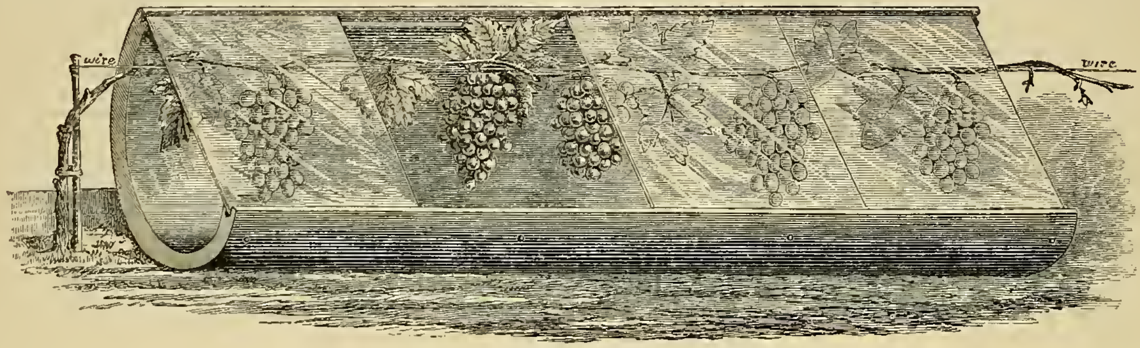


FIG. 2



tooth may be employed at suitable intervals along the saw. The principal advantages derived from this improved construction of saws are the smoothness left on the cut surfaces of the wood, the freedom with which they pass through the material operated upon, and the capability of cutting equally well in both directions.

RENDLE'S FRUIT-TREE AND PLANT PROTECTORS.—We noticed briefly last month, in our report on the Royal Agricultural Show, these ingenious and useful aids to the gardener, and we have much pleasure in giving an illustration of one of Mr. Rendle's protectors as adapted for a grapery. It consists chiefly of a nearly cylindrical hollow earthenware tile, somewhat similar to a drain pipe, with a portion of one side removed. If intended for such plants as strawberries, holes must be provided at suitable intervals along the bottom of the protector for the plants to grow through. Along each of the opposite edges of the longitudinal opening in the top of the protector grooves are formed for the reception of moderate-sized sheets of glass, any one of which may be readily removed, to afford access to the fruit beneath it inside the protector. Mr. Rendle adapts his protectors to peach, nectarine, apricot, and other delicate wall-fruit trees, as well as to the vine and strawberry; the protector in the former cases being secured to the wall on each side of the main stem of the tree in horizontal or nearly horizontal lines, along the interior of which the fruit-bearing branches are trained—the fruit being thus effectually protected by the glass above it. These protectors are cheap, and of so simple a construction that any one may use them; and being made in short lengths joined up, they are readily removed from place to place, or from one crop to another. They insure sufficient light for ripening the fruit, whilst at the same time they store up a large percentage of heat for nightly use, when the light and heat of the sun are withdrawn.



TEA CULTIVATION IN INDIA.—The cultivation of tea on the Neilgherry hills, says the *South of India Observer*, promises to become of greater importance every year, both to the planters and to the Government. At the late local flower show specimens were exhibited from Ootacamund and Coonoor which would bear comparison in quality with any of the finest productions of China or Assam. As regards aroma, we can safely say that no teas in the world can beat the produce of the Blue Mountains. Botanists account for this by the great elevation of the plantations, some of them being upwards of 6000 feet above the sea level. Nearly all the seed which was purchased from Assam and the North-West turned out to be bad. Year after year, owing to the tendency of tea seed to "sweat" when packed in boxes or bags, nothing but failure awaited the Neilgherry planter. The Neilgherry climate is peculiarly trying to young plants. Owing to the rarefied state of the atmosphere the radiation and evaporation at some seasons are excessive; and while the plants have to sustain great heat from an unclouded sun during the day, they are subjected to severe cold during the night. Tea planting on the Neilgherries may be said to be a study, altogether different from that in any other climate. It was not understood at the commencement. Young and tender plants were put out in the same fashion adopted in the moist, soft climate of Assam. Now, however, that the planters have, at heavy cost to themselves, gained the fullest experience, the system in future will, doubtless, be successful.

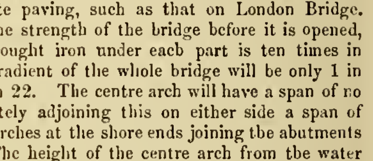
RAILROAD TRACKLAYER.—The railroad tracklayer is now working along regularly at the rate of a mile a day. The machine is a car 60 feet long and 10 feet wide; it has a small engine on board for handling the ties and rails. The ties are carried on a common freight car behind, and conveyed by an endless chain over the top of the machine, laid down in their places on the track, and when enough are laid a rail is put down on each side in proper position and spiked down. The tracklayer then advances, and keeps on its work until the load of ties and rails is exhausted, when other car loads are brought. The machine is driven ahead by a locomotive, and the work is done so rapidly that sixty men are required to wait on it; but they do more work than twice as many could do by the old system, and the work is done quite as well. The chief contractor of the road gives it as his opinion that, when the machine is improved by making a few changes in the method of handling rails and ties, it will be able to put down five or six miles per day. This will render it possible to lay down track twelve times as fast as the usual rate by hand, and it will do the work at less expense. The invention will be of immense importance to the country in connection with the Pacific railroad, which, it was calculated, could be built as fast as the track could be laid, and no faster; but hereafter the speed will be determined by the grading, which cannot advance much more than five miles a day. Thirty millions of dollars have already been invested on the Pacific railroad; and if the time of completion is hastened one year by this tracklayer, as it will be if the Central and Union Companies have money enough to grade each five miles a day, there will be a saving of three million dollars on interest alone on that one road.—*Alta California.*

THE FOREIGN COAL AND IRON TRADES.—The contract for what is known as the Crèvecœur Bridge (in Holland), which will involve the employment of 2300 tons of iron, has been let to an English house, viz., Messrs. Lloyd, Foster, & Co., of Wednesbury, Staffordshire, the amount of whose tender is £53,380. The next lowest tender was that of a Utrecht firm. Other English tenders were delivered as follows:—Butler & Co., Leeds, £56,480; Watkins, Middlesborough, £59,528; Palmer & Co. (Limited), Newcastle, £60,774; Leeds Railway Works, £65,869; Worcester Engineering Works, £71,240; and Messrs. T. Brassey & Co., £89,400. It appears doubtful whether the increased activity which has been remarked upon the French iron markets can really be taken to indicate a serious revival in affairs. A tolerably regular current of orders has been received of late by Belgian metallurgical works. The annual report of the Charleroi Chamber of Commerce, which has just been issued, complains that, while the imports of coal from other countries into Belgium are increasing, the exports of coal from Belgium are decreasing, having fallen last year to 3,564,364 tons, as compared with 4,071,772 tons in 1866. It would seem that Belgium imported last year 169,000 tons of British coal.—*Times, 18th July,* 1868.

NEW BLACKFRIARS BRIDGE.—Each arch is built of nine massive wrought-iron ribs set at a distance of 9 feet 6 inches asunder. This is a much greater distance apart than that at which those of Westminster are set, but, on the other hand, those at Blackfriars are much more than twice as strong, being 3 feet 10 inches deep at the crown of the arch and 4 feet 7 inches at the springing. The cross braces between these ribs are of proportionate strength and depth, and are placed at intervals of 17 feet apart. Above these come what are termed bearers, and bolted over these again will be powerful buckle plates for the roadway. These buckle plates will be thickly coated with asphalte, then a layer of hard stone rubble, and over all the usual granite paving, such as that on London Bridge. There will be no test used to prove the strength of the bridge before it is opened, because the sectional area of the wrought iron under each part is ten times in excess of any possible strain. The gradient of the whole bridge will be only 1 in 40: the rise in the old bridge was 1 in 22. The centre arch will have a span of no less than 185 feet, the two immediately adjoining this on either side a span of 175 feet each, while the two smaller arches at the shore ends joining the abutments will have a span each of 155 feet. The height of the centre arch from the water is to be 25 feet; of the two next side arches 21 feet 6 inches, and of the two shore arches 13 feet 3 inches. All the arches will be of a flat elliptical shape, and will give together a waterway more than one-third greater than that of the old bridge. The total length of the new bridge will be from end to end 960 feet, or about 60 feet longer than Westminster. Its breadth will be 80 feet, or almost exactly double that of the old bridge. The roadway alone is to be 45 feet wide, or about 2 feet wider than the whole of the old bridge from outside to outside, and there are besides these to be two footways of 17 feet width each. As to the granite buttresses, it is affirmed that finer ones have never been erected for any bridge in England. The blocks which compose these massive towers are all of dressed granite, and though weighing from 12 to 15 tons each they are fitted together with the accuracy of cabinet work, and, in fact, are able to bear comparison with the granite work of the Thames embankment itself. It is believed that the bridge will be open for traffic at the end of the year, although all its ornamental details will not be completed until May.

GLOVE FASTENINGS.—The accompanying engravings illustrate a simple and effective fastening for gloves, invented by M. A. Geminel, of Paris, which consists in constructing such fastening by stamping or punching from a sheet of thin metal one of the two parts constituting the fastening, this part having a tongue-piece formed therein by suitably slitting the centre portion; an ornamental device is also stamped or formed on one end of the piece, which is to be doubled or bent over the tongue when attached to the glove, the tongue itself being also slightly elevated underneath the ornamental part, so as to leave a recess on the under side of the piece for the engagement of the other part of the fastening. The other part of the fastening consists of a stamped or punched plate having a catch or projection formed in the centre, which is to be turned up at right angles to the surface of the plate after it has been cut. Both these parts are attached to the glove by sewing, or by the aid of metal clasps provided with sharp points, which are inserted through the material of the glove and fastening and then secured by bending them down. The fastening is secured or connected by simply inserting the projection of one half into the recess in the underside of the opposite half, the sides of such recess serving to guide the projection into its proper place. By tapering the recess, and making the projection which engages therein wider at the top, the latter will be effectually locked therein on being drawn towards the narrower end of the recess. Fig. 1 is a view of the guide-foot, *a*, punched out, and fig. 2 a side view of the same, showing it as it is put on the glove after the turning down of the ornamental part; fig. 3 is a longi-

Figs. 1—5.



tudinal section; fig. 4 is a plan; fig. 5 a section of the fastening piece, hook, or pin carrier. It is preferred to first punch out the foot, *a*, terminating in an ornamental piece, *b*, which is subsequently turned down, as shown in fig. 2, on to the glove, in imitation of a button. In the interior of the foot, *a*, a tongue piece is formed, *c*, which being slightly raised, forms a recess under the glove to receive the pin, *d*. The pin, *d*, is formed by a small tongue piece, made at the time of the punching operation, in a metal disc, e, provided with two small holes, *i*. The two parts, *a* and *d*, may be attached to the glove by sewing, or by preference by means of a small pin, *k*, which passes through the glove and enters the holes, *i*, and is then turned down either on the outside or inside of the glove. In order to fasten the glove, the foot, *a*, is drawn forward or made to slide over the pin, *d*, which engages in the recess formed by the raised portion of the tongue, *c*, the parts being made of the most suitable form to facilitate the fastening. This system of fastening is exceedingly simple, and may be applied with facility.

THE MARITIME EXHIBITION AT HAVRE.—The *Journal du Havre* has an article on the appliances exhibited for the coating of the bottoms of iron vessels, from which we take the following:—"Water, like time, has the sad privilege of destroying everything: and sea water on iron produces rust. Decomposition advances with astonishing rapidity. In a few months the iron is reduced to a granulated and friable substance; deep cells are eaten into it, and sometimes perforate the entire thickness of the metal. Another formidable agent of destruction is the numerous tribes of crustacea, molluscs, and especially the barnacles, mussels, and seaweed, which adhere to the ship's bottom and impede its progress. A few months back an English vessel, which sailed eleven knots an hour at its departure, found its speed reduced to four knots, and on coming into port 40 tons of shells and seaweed were taken from its bottom. The *Great Eastern*, on its return from laying the electric cable, had 150 tons scraped off her hull. The question of the gradual deterioration of iron vessels has appeared to be of vital importance to the governments, as their navies were menaced with rapid and inevitable destruction. The aid of men of science was called in, and liberal rewards were offered for a remedy. The English government promised a sum of £3000. A number of inventors set to work, and the result was that in a short time not less than 400 patents for the object in view had been taken out. The results did not, however, appear conclusive, and the Admiralty did not award the prize to any of the competitors. The inventors had placed under contribution all the resources of chemistry and toxicology. Among the remedies proposed were mercury in its metallic state, combined with grease, arsenic, sulphate of copper, white lead, verdigris, minium, metallic zinc, baryta, antimony, powdered glass, prussiate of potash, hydraulic cement, iron, and manganese, besides caoutchouc, gutta percha, tallow, soap, asphalt, linseed oil, petroleum, naphtha, turpentine, resin, tar, creasote, phosphorus, acids, &c. Some compositions of real merit have alone survived. The Maritime Exhibition of Havre offered to inventors a favourable opportunity for calling the attention of shipbuilders and the public to the merits of their discoveries. A few have taken advantage of it. Messrs. Peacock and Buchan, of Southampton; M'Innes, of Liverpool; and Gisborne, of London, have exhibited different species of compositions. That of Messrs. Peacock and Buchan has been for a long time in use. The ingredients of which it is made are a secret. All we can say is, that it is of a red or rose colour. The bottom of the vessel, after receiving a coating of minium, receives two of the composition. It does not dry very quick. Their paint No. 4, however, dries more promptly, and according to their circular, there is no need to put the vessels into dry dock to apply it, as it may be laid on in a single tide; but as the hull has to be warmed and scraped dry, the operation is not so simple. Mr. M'Innes, of Liverpool, exhibits an invention dating from 1854, and consisting of a metallic soap, to which mineral poisons may be added. A coat of paint is first applied, and then two of the composition, warm and in a liquid state. The object of this application is to protect the iron from oxidation, and to present a poisonous smooth surface, to which neither barnacles nor marine plants can adhere. Another composition by the same inventor, the ingredients of which are not known, has the property of preserving the iron from corrosion, and preventing the damp from penetrating. As to the poisoning of molluscs, that is, we believe, a purely Utopian idea, for even were animals sensible to poison, which is doubtful, and should the poison preserve its efficacy, which is still more questionable, the molluscs are, from their birth, covered with a slimy substance which isolates them from all dangerous contact. Nor do we believe in the impossibility of their adhering to the polished surface of those substances, as the crustacea attach themselves even to a pane of glass. Mr. Gisborne gives the receipt for his composition, which contains quicksilver, powdered glass, &c., mixed with boiled linseed oil; he also recommends the ship's bottom to be first coated with minium, or any other paint. We have next to examine a group of vegetable compositions which are, in our opinion, destined to lead to great progress in the preservation of vessels in salt water. In the first place we may mention caoutchouc, which, being mixed with sulphur, or vulcanized, becomes eminently appropriate for the use in question. By that means it is rendered impervious to water and damp, and insensible to cold or heat. Employed in a liquid state it can be spread like common paint, while it dries with astonishing rapidity, and is indestructible. There are many compositions having caoutchouc for their basis, prepared in different manners and in various proportions. Captain Roux, of the Imperial Navy, took out, in 1864, a patent for an anti-corrosive composition, the ingredients of which are, 10 parts of caoutchouc and 35 of spirits of turpentine; to which he adds in small quantities an impalpable powder, consisting of 60 parts of sulphate of baryta, 23 sublimate of sulphur, and 12 of white lead. Those substances being incorporated with the caoutchouc in solution, must be kept in hermetically sealed jars. M. Bouquet, a chemist of Havre, exhibits a composition he calls Indianite, and which consists of 100 parts of caoutchouc, 15 of resin, and 10 of shell-lac. This composition becomes hard in a very short space of time. It may be then reduced to a liquid state by the addition of bi-sulphuret of carbon. When applied it dries rapidly, and its power of adherence is such that it can scarcely be torn from the surface on which it has been laid. It is impervious to wet, and is not affected by heat or cold. It may be used on copper, zinc, and other metals, as well as on wood, stone, or brick. The Indianite is used with equal advantage to metals exposed to the air or to sea water. It is applied cold, and does not require to be preceded by a coating of minium, as most of the other compositions. The iron reservoir of the aquarium in the Exhibition has been coated both inside and out with Indianite, which has prevented all rust, and has preserved the water from all discoloration.

NEUTRAL CARBONATE OF AMMONIUM.—The existence of the neutral carbonate of ammonium is announced, and the properties of this long-wanted salt described, by Dr. Diners in the *Philosophical Magazine*. We need hardly remind our readers that the ammoniæ carbonas of the Pharmacopœia is an anhydro-sesquicarbonate of ammonium, and not a combination of equivalent qualities of ammonia and carbonic acid. Dr. Diners states that the neutral or normal carbonate is a crystalline substance, of ammoniacal odour, passing rapidly to the state of bicarbonate, very soluble in water, and sparingly soluble in rectified spirit.

FORCE.—The *Quarterly Journal of Modern Science* contains a thoughtful paper on the modern aspects of physical science, which directs attention to the action of molecular force as the great problem of the day. There seems little room for doubting that force is one, and that heat, light, electricity, and the like, are varying exhibitions of its energy, probably indeed only various modes of action. But meanwhile "we have still to inquire what is it that is moved, and where is the mover?" Empty space or thinnest ether separates sun and planet, star and earth: What are the lines composed of along which light, heat, attraction, travel from the one to the other?

THE THAMES EMBANKMENT.—Some idea may be formed of the magnitude and importance of the undertaking when we say that a river wall in granite, 8 feet in thickness, has been built so as to dam out nearly 30 acres of the river; that this wall is nearly 7000 feet long, that it averages more than 40 feet high, and its foundations go from 16 to 30 feet below the bed of the river. In the formation of this wall and the auxiliary works of drainage, subways, and filling in with earth behind it, there have been used nearly 700,000 cubic feet of granite, about 30,000,000 bricks, over 300,000 bushels of cement, nearly 1,000,000 cubic feet of concrete; 125,000 cubic yards of earth have had to be dug out, and no less than 1,200,000 cubic yards of earth filled in. Such stupendous quantities of material, expended over so short a space of ground, have never been heard of till now.—*Times.*

ENGLISH AND PRUSSIAN ARTILLERY.—During the last two months a series of gunnery experiments, not yet completed, have been going on at Tegel, near Berlin. In these trials the English Woolwich gun has been pitted against the celebrated Krupp gun. The result, as described in the *Pall Mall Gazette*, is to demonstrate the decided superiority of the English gun. There were three targets. Before the Woolwich gun arrived some practice had been made with an 8-inch Krupp gun at No. 1 target, at 1030 yards, with chilled steel shell. One of these shells had broken up on striking without damaging the plate; the other had effected a partial penetration, and remained sticking in the plate, nearly the whole of the cylindrical part being exposed. The 9-inch Krupp gun nearly penetrated this target, the nose of the shell just appearing through the skin. When the Woolwich gun was discharged at this target (blind Palliser shell), it penetrated the target with great ease, the splinters sweeping away the whole of the wood screens erected behind the target. No. 2 target was fired at—at a range of 700 yards—with the 9-inch Krupp gun. It was not penetrated. The shot again stuck in the target. The Woolwich gun, firing blind Palliser shell, penetrated this target easily. In every instance, the practice with the Krupp gun, as far as penetration was concerned, was more or less of a failure. In every instance, the English gun and projectiles achieved a complete and remarkable success. The result occasioned the keenest vexation abroad, and led to many angry recriminations, and even in one instance, if we are not misinformed, to the dismissal of an officer holding a high official position. The result has been that the Prussian authorities have remodelled their system after the English pattern. They have adopted precisely the same form of projectile, although the lead which it bears renders it slightly heavier. They have stripped it of its coating as far as they could venture to do, and they have increased their charge of Prussian powder to 53 lbs., which they find to be as nearly as possible the equivalent of 43 lbs. of English powder. The Krupp gun then produced the same effect as the Woolwich. It is, however, one or two tons heavier—the Armstrong weighing 12 tons, and the Krupp 14½.

FURNACES.—Mr. Thomas Whitwell, of Thornaby Ironworks, has patented (11th January, 1868) an invention which relates to certain improvements applicable to several varieties of furnaces, but more particularly to such as are used for puddling, boiling, and heating iron and steel, and other like purposes. He thus describes the improvements:—"In carrying out my said invention I construct the flue-neck of the furnace, by which I understand that part of the furnace where the working part ends, and the passage or flue for the products of combustion begins, with a cast-iron frame, A (see engraving), through which frame I cause water to flow by any well-known contrivance, such as circulating pipes, which I regulate in any well-known manner. The pipes may be of any suitable material, but I prefer wrought-iron pipes, B, inclosed or cast within the cast-iron frame, A, the supply of water to the same being regulated by a valve or tap. This water frame, A, is placed in the neck of the furnace, in a convenient position. The waste gases of the furnace pass through the same, and the advantage gained is regularity in the consumption of fuel. For example, the gauge of the flue-neck of a furnace having been fixed,

Fig. 1.

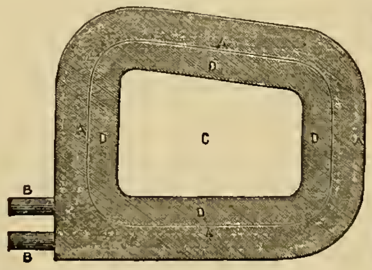
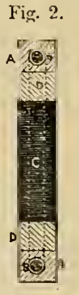


Fig. 2.



the opening, C, in the frame, is made of the same area; and the frame being kept cool by the circulation of the water therein, the gauge will not be varied by the action of the waste gases, and the consumption of fuel will be equalized for a considerable period. I sometimes place bricks or other refractory material on the lower part of the frame, or I line the whole of the inside of the frame with bricks or other refractory material, D, as shown, and I sometimes construct the frame or gauge of fire-clay (or other suitable material), bedding the water-pipes therein. I also sometimes construct a coil of water-pipes, of any suitable material, and build within the coil bricks or other suitable material to the gauge required, or I construct a 'lump' of fireclay or other suitable material, and surround the same with a coil of pipes as aforesaid, having water circulating through them for the purpose of preserving the gauge; in all cases the supply of water will be regulated by a valve or tap."

A Gun to Fire 250 Shots a Minute.—The Prussian correspondent of the *Daily News* says—Some experiments have just been made at Königsberg with the new arm called the Kugelspritze, or bullet squirt. It has thirty-seven barrels, all of which can be fired from six to nine times a minute, thus making from two to three hundred shots in all. The weapon, resting on a support, is fired like a rifle, the recoil being broken by a strong spiral spring. The results do not appear to have been very satisfactory.

The Great Bridge at Runcorn.—The great bridge and viaduct over the Mersey at Runcorn are now complete, and there now only remains to be completed the embankment on the Lancashire side of the river, to be formed of about 65,000 cubic yards, of which about 35,000 yards will be carried over the bridge from the Cheshire side. The construction of this bridge has been attended with great difficulties. The most formidable difficulty with which the contractors have had to contend is the great and rapid rise of the tide in the Mersey. The tide rises 20 feet in 2½ hours, and comes in with so much force that the greatest care and forethought were necessary to prevent the incomplete works from being carried away. When finished, the Runcorn Railway will enable the London and North-Western to save about 15 miles in the journey from London to Liverpool.

Gas for Steam Boilers.—Gas is being used to some extent in London for generating steam in small steam boilers. In the Thames granaries it is thus used, the steam being raised from cold water in twenty minutes, and maintained by a single burner. The cost is trifling, and labour and space are economized. A boiler on this principle was recently exhibited at the *soirée* of the Institute of Civil Engineers, the burners being on Bunsen's principle.

The Mont Cenis Tunnel.—During the month of July the progress made at the Mont Cenis Tunnel has been 123 metres, of which 60 metres was the length driven on the French side at Modane, and 60 metres at Bardonnèche, on the Italian. The position of these works up to the 31st July was as follows:—

	Metres.
Length driven at Modane,	3,528
" " Bardonnèche,	5,119
Total length of tunnel driven,	8,647
Length remaining to be driven,	3,573
Total length of tunnel,	12,220

The boring is now going on more rapidly than before, as the character of the rock through which the tunnel is being driven is softer.

Charcoal Filters.—The employment of charcoal filters has long been advocated, on account of the known property of this substance to absorb and oxidize organic matter. Mr. W. Skey, of New Zealand, has now shown that charcoal will remove arsenic from water. If a few drops of a solution of a salt of arsenic, or arsenious acid, be put into a few ounces of dilute sulphuric acid, and the mixed solution agitated at intervals with recently ignited charcoal for an hour or two, the clear liquid obtained by filtration does not manifest any reaction of arsenic when tested by Marsh's process. Tungstic acid also is removed from acid solutions by charcoal applied in like manner, and is given up to a solution of caustic alkali.

A New Flux.—A new flux is attracting considerable attention in America, and appears destined to become of great importance in several metallurgical operations. It is known as Stevens' flux, and Professor Hayes, a competent authority, speaks of it in the following terms:—"The new flux is a residue remaining after the extraction of soda from the mineral cryolite, and consists of fluoride of calcium and aluminium, with some caustic and some carbonate of lime, in varying proportions, a little silica and oxide of iron."

Scientific Instruction of the People.—The following are the conclusions with which the Select Committee of the House of Commons appointed to inquire into the provisions for giving instruction in science to the industrial classes terminate their report:—"(1.) That with the view to enable the working class to benefit by scientific instruction it is of the utmost importance that efficient elementary instruction should be within the reach of every child. (2.) That unless regular attendance of the children for a sufficient period can be obtained little can be done in the way of their scientific instruction. (3.) That elementary instruction in drawing, in physical geography, and in the phenomena of nature should be given in elementary schools. (4.) That adult science classes, though of great use to artizans, to foremen, and to the smaller manufacturers, cannot provide all the scientific instruction which those should possess who are responsible for the conduct of important industrial undertakings. That all whose necessities do not oblige them to leave school before the age of 14 should receive instruction in the elements of science as part of their general education. (5.) That the reorganization of secondary instruction and the introduction of a larger amount of scientific teaching into secondary schools are urgently required, and ought to receive the immediate consideration of Parliament and of the country. (6.) That it is desirable that certain endowed schools should be selected in favourable situations for the purpose of being reconstituted as science schools, having in view the special requirements of the district; such schools to be rendered available to the surrounding districts by the establishment of exhibitions open to public competition, so that the children of every grade may be able to rise from the lowest to the highest school. (7.) That the superior colleges of science and schools for special scientific instruction requiring costly buildings and laboratories cannot be supported by fees alone, without aid from one or more of the following sources—namely, the state, the localities, and endowments or other benefactions. (8.) That such colleges and special schools are most likely to be successful if established in centres of industry, because the choice of such centres tends to promote the combination of science with practice on the part both of the professors and of the pupils; and to enable many to attend them to whom the expense of living at a distance from home would otherwise be an insuperable barrier. (9.) That the provinces of England, especially the agricultural districts, have not received a sufficient proportion of the state grants for scientific education. (10.) That those provinces of England are entitled to such a modification of the public grants as will afford them increased aid, supplementary to the funds which they may raise in their own localities for the purpose of promoting scientific instruction. That grants of money from the national exchequer for local scientific instruction should be chiefly designed to promote local activity, and a better use of resources otherwise available, and should be regarded as occasional or temporary. (11.) That some slight addition to the emoluments of science teachers would probably tend materially to promote the establishment and permanence of elementary science classes. (12.) That the provisions of the Public Libraries and Museums Act should be altered so as to enable public bodies to levy a slightly increased rate for scientific purposes. (13.) That the managers of training colleges for the teachers of elementary schools should give special attention to the instruction of those teachers in theoretical and applied science, where such instruction does not exist already. (14.) That teachers in elementary day schools should be paid on results for teaching science to the older scholars, in the same way as payment is now made for drawing in such schools. That the education of higher science teachers should be encouraged, by the granting of degrees in science at Oxford and Cambridge as at other universities, and by the opening of a greater number of fellowships to distinction in natural science, as well as in literature and mathematical and moral science. (15.) That a more intimate connection between the various government institutions for scientific instruction in London would increase the efficiency of each of those institutions, and that the constitution and management of those institutions and their future relations to each other require further investigation."

Rock Drilling.—A new diamond drill for perforating rocks has been recently constructed by the Windsor Machine Manufacturing Company in the United States, which is said to answer admirably. Instead of setting the diamonds in the form of a ring, which when rotating forms a cone, and has proved a failure, the diamonds are so set as to form a solid drill-head, cutting the full size of the hole. The drill is worked by a small oscillating steam-engine, connected with the drill carriage. It is stated that 500 feet have been bored in granite, marble, and quartz with one drill-head without the slightest appreciable wear in the diamond points.—*Athenæum*

Fig. 1.

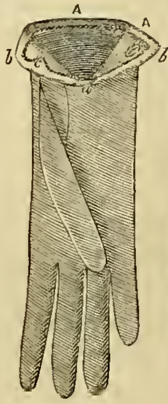
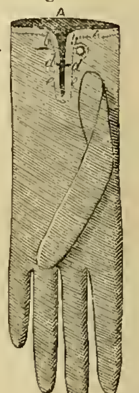


Fig. 2.



Gloves.—Mr. James Wheeler, of 210 Regent Street, Middlesex, has patented (7th November, 1867) an invention which has reference to what is called the welts of kid and other like gloves, and consists in extending the welts, without any join, entirely round the upper part of the glove, and along the sides of the opening in front, the said welt commencing and terminating at the bottom of such opening or otherwise, in which case the said opening is strengthened at the bottom, whilst all seams and multiple thicknesses or folds of material at the corners are avoided Or the welt may be joined only at the two sides of the front opening, just below the button and button-hole, or other fastening. The corners are curved or rounded, in lieu of being left square or pointed as at present, whereby a neater appearance will be imparted to the glove. If desired, the patch or covering which is usually stitched over the back of the button or fastening may be made in one piece with the inner portion of the welt. Fig. 1 of the accompanying drawings represents a kid glove constructed according to one mode of carrying out this invention. The top of the glove is opened sufficiently to show a portion of the interior, and thereby render this mode of applying the welt more clearly understood. A A represents the welt, which it is preferred to make double. This welt, as will be seen on referring to the drawing, extends in one piece continuously, or without any break or joint, not only round the top of the glove, but also along both sides of the front opening; the two ends of the said welt being crossed over each other, and securely stitched together at the bottom, *a*, of the slit or front opening, as shown clearly in the drawing. As there will be double the thickness of material at the bottom of the opening, it follows that increased strength will be given to that part. In lieu of cutting the corners of the glove at the top of the front opening square, as heretofore, such corners may be rounded off, as shown at *b b* (figs. 1 and 2), whereby the welt may be more neatly stitched round that part, and a generally neater appearance is imparted to the glove. *c* (fig. 1) represents the patch for covering the back of the button or other fastening, which patch is sometimes made in one piece with the welt, as shown in the drawing. In the modified form or mode of applying the welt shown in fig 2, the welt is jointed at *d d* to a second piece, *e*, the joins being situated a little below the rounded corners, *b*, and below the button and button-hole or other fastening.

Iron Manufacture on the Pacific Coast.—The Oregon Iron works have recently forwarded to San Francisco two invoices of iron, and have altogether about a thousand tons to send to the same market, the iron being for use in the foundries in the vicinity of the above-named city, small samples that were tried during the past year having given good satisfaction. The manufacture of pig iron on the

Pacific coast is a want which has long been felt, and although the Oregon works will be able to supply only a small portion of the demand, their successful inauguration will eventually lead others into the same manufacture, until California shall be placed quite independent of the East for this heavy and important item of consumption. The rolling mills of San Francisco are nearly ready to go into operation. These two enterprises will form important additions to its rapidly increasing industrial productions. Their successful establishment will make still more apparent the need for converting furnaces, so that California may make its own wrought iron and steel. Each will be dependent upon the other, and will unite in a demand for a thorough examination and development of the immense natural resources for the production of raw iron which exist in that State.—*American Artizan.*

Manufacture of Paperhangings in Italy.—At Turin there are two manufactories of paperhangings, the first employing 25 workmen, and the second 16; the products of both these manufactories are distinguished by the excellence of the work and the brilliancy of the colours, and at the same time by their cheapness. They produce annually about 50,000 kilos. of paperhangings, at prices varying from 60 centimes to 3 francs per metre. At Milan there are nine establishments, employing in all 60 workpeople and 48 children. The average wages are 1fr. 50c. per day for the adults, and 44c. the children. The colouring is done by hand, and the quantity of paper used yearly is 30,000 rolls of 7 metres each, and 200 reams of paper, called *leone*, for ceilings. There is also another manufacture at Fibreno, in the Neapolitan provinces, which produces excellent qualities of paperhangings, such as flock, gilt, marbled, and glazed, which can compete with foreign productions. The following are the imports of the best qualities of hangings to Italy, and the trade is almost exclusively with England and France:—

Plain coloured paper.

	Kilos.	Francs.
1863, ...	209,100	657,000
1864, ...	82,400	247,000
1865, ...	10,800	151,000

Flock and other fancy sorts.

	Kilos.	Francs.
1863, ...	132,200	327,000
1864, ...	306,200	756,000
1865, ...	408,700	1,009,000

The Soda Lakes of Mexico.—The Lake of Tescoco, a short distance from the capital of Mexico, and communicating with the city by means of a canal, is one of the greatest natural curiosities of that country. In the centre is a barren island, with a hill composed of volcanic rock, and known as El Penon de los Banos, or rock of the baths, rising from the surface. This desolate spot is famous for the manufacture of crude soda, or tequesquite, a manufacture not more remarkable for its primitive method than its vast resources. The earth of the valley adjoining the lake is impregnated with a species of soda, and Lake Tescoco itself is a concentrated solution of soda. It contains an immense deposit of the salts of sodium, chiefly the chloride of sodium and the carbonate of soda. The lake has great surface and small depth, and with a rainy season of four months and a dry season of eight, its range of expansion and contraction is from 220 square miles at its maximum to 80 square miles at its minimum. A calculation of the contents of the lake was made in 1851, when the lake was considerably contracted, and the proportion of solid matter was ascertained to be not less than 18 per cent. The Penon soda stills are not numerous, but illustrate the rude principles at work all around the lake. They are simply mounds of accumulated dark, bluish mould, on which large round holes are made here and there. In these holes bags are placed, and in the bags the impregnated, frosty-looking earth found every morning along the lake. Over this earth water is poured, and the liquor which sinks through the dirt, and is drained from the bags, passes into a vessel below. The solution thus caught is evaporated over a fire, and tequesquite is the result. This is the whole process, which is the same that was used in the days of Montezuma. With this primitive system of manufacture the lake, according to the estimates of the School of Mining in the city of Mexico, produces annually 1,680,000 pounds of crystallized or pure soda, and 3,696,000 pounds of tequesquite or impure soda.

Mineral Statistics of Italy.—The following is the average annual produce of the mines and metal works in Italy at the present time:—

	Mines.		Works.	
	Quantities.	Amount.	Quantities.	Amount.
	Kilos.	Frs.	Kilos.	Frs.
Iron, . .	143,499,300	2,053,330	57,004,900	16,444,000
Copper, . .	32,010,100	1,551,692	1,012,200	2,793,706
Lead and silver,	16,047,700	2,935,285	12,936,100	5,986,758
			6,626	1,409,235
Gold ore, .	103,800	9,100	125	236,331
Gold native, .	94	226,551		
Mercury, .	4,760,800	56,600	29,600	126,040
Zinc, . .	282,800	10,000	80,000	36,000
Antimony, .	100,000	50,000	50,000	60.000
Nickel, . .	7,000	1,043	37,600	131,631
Iron pyrites, .	4,750,000	25,900	—	—
Manganese, .	826,000	41,670	—	—
Coal and other fossil fuel, .	119,870,700	1,022,868	20,000,000	800,000
Sulphur, . .	168,681,700	18,671,784	8,225,000	1,346,000
Boracic acid, .	—	—	1,805,500	1,445,890
Total, . .	. . .	26,655,823	. . .	30,815,591

Indian Railways.—The total number of miles of railway now open in India is 3943. The total amount of capital raised for Indian railways on the 31st of March last was £76,579,016, of which £60,048,871 consists of shares or stock, and £16,530,145 of debentures. The total expenditure on railways to the 31st of March last was £75,071,656. The expenditure of the year ending at that date was £7,000,000, of which £4,000,000 were expended in England. The gross receipts for the year ending the 30th of June, 1867, were £4,878,527, and the working expenses were £2,537,812; the net receipts were consequently £2,337,300. In 1867 the number of passengers was 13,746,354, of which upwards of 13,000,000 were third class. The sums received from passengers and on account of goods carried were, respectively, £1,376,812 and £3,320,607. The Home Government has come to the conclusion that the present is a fitting time for taking a comprehensive view of our railway policy, past and future, for reviewing what has been already done, and for endeavouring to establish principles on which we may proceed henceforward. The Indian Government has therefore been requested to take a general survey of the whole of India, and to state its opinion as to the lines which are most desired, as well as to the order, mode, and rate of progress in which they should be taken up. Each of the local governments has been invited to consider what lines of railway they would regard as desirable to construct, should the necessary funds be available, either within their respective territories, or to communicate with the most important points in the territories adjacent, whether British or foreign; the object being to insure such a review of all possible lines as will enable the Government of India and the Secretary of State to make a selection of those particular lines which are most needed, and which most commend themselves for early construction.

Thin Sheet-iron.—Some time ago, in the United States, a piece of sheet-iron, the 1000th of an inch thick, was rolled, and upon which a letter was written and sent to Pittsburg. After repeated experiments Messrs. Hallam & Co. have rolled a sheet so thin that 4800 are required to make a thickness of an inch.

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

17th July, 1868.

2246 G. Moulton, Manchester—Pentagraph engraving machines
2247 W. J. Ellis, Barnsbury Park—Cranes
2248 E. Funnell, Brighton—Signalling on railways
2249 C. P. Stone, Dorset Square—Vessels of ware
2250 A. Woollan, Notting Hill—Protector for securing watches
2251 J. Duguid, the younger, Glasgow—Paper
2252 W. J. C. Muir, Westminster—Permanent way of railways
2253 C. J. Galloway, and C. H. Holt, Manchester—Boilers for generating steam
2254 W. and W. T. Eades, Birmingham—Obtaining motive power
2255 A. Browne, King William Street—Liquid meters.—A com.
2256 J. Roberts, King William Street—Vessels for preserving liquids
2257 S. Deacon, Hoxton—Fastenings
2258 R. Meldrum, Pittormie—Raising and discharging fluids
2259 E. A. Cowper, Westminster—Glass ornaments

18th July, 1868.

2260 D. Sowden and R. C. Stephenson, Bradford—Shuttles.—A com.
2261 D. Webster, Southport Gas Works—Gas
2262 T. Kendrick, Birmingham, and S. Davies, Dudley—Fire-irons
2263 C. G. Johnson, Stockton-on-Tees—Kilns for drying bricks
2264 J. Gill, Halfway Street—Motive power engines
2265 J. Thomas, Newcastle-upon-Tyne—Furnaces for smelting
2266 W. Berry, Kingsland Green—Lighting shops
2267 F. C. Steinbach, Brussels—Metallic pipes
2268 W. R. Lake, Chancery Lane—Propelling machinery for canal boats.—A com.

20th July, 1868.

2269 T. Bonell, Newcastle—Slide valves of steam engines
2270 H. B. Barlow, Manchester—Spinning cotton.—A com.
2271 T. W. Gray, Limehouse—Lightning conductors
2272 W. Winter, Leeds—Sewing machines
2273 W. G. Cunningham, Oxford Street—Lowering windows
2274 E. Beans, Cordwallis—Brewing
2275 R. Smyth, Glasgow—Propelling vessels
2276 C. P. Wilcox, Mold—Counting machine
2277 T. G. Green, Church Gresley Pottery—Manufacturing earthenware
2278 L. Rose, Leith—Artificial champagne
2279 R. Brett, Gislingham, and G. Daniels, Bentley—Agricultural implements
2280 J. Raine, Richmond—Panoramic pictures
2281 C. Hodgson, Richmond—Transporting loads
2282 W. H. Bates and A. M. Bates, Leicester—Manufacture of hose
2283 A. Homfray, Halesowen—Separating impurities from coal
2284 C. Weekes, Westminster—Applying iron for building purposes

21st July, 1868.

2285 F. Green, Fulham—Lamps
2286 T. Kohn, Hartford—Finishing silk
2287 T. Deschamps, Paris—Fastenings for gloves
2288 F. Warren, Birmingham—Heating water for conservatories
2289 A. A. Wille, Woodford—Bleaching feathers
2290 J. M. Hector, Blandford Saint Mary—Fusee boxes
2291 J. J. Aston, Middle Temple Lane—Propulsion of vessels
2292 A. M. Clark, Chancery Lane—Feeding steam boilers.—A com.

22nd July, 1868.

2293 T. Gibb, Jarrow-on-Tyne—Treating metallic ores and compounds
2294 G. Martin, Strond—Manufacturing extract wool
2295 C. W. Bradshaw, Stubbington—Coupling hose
2296 J. H. Johnson, Lincoln's Inn Fields—Producing colouring matters.—A com.
2297 S. Langdale, Newcastle-upon-Tyne—Preparing artificial manures
2298 P. Tassie and Isaac Patchett, Manchester—Plaiting textile fabrics
2299 W. T. Hamilton, Dublin—Dove-tailing machine
2300 C. F. Wald, Cheapside—Raising water.—A com.
2301 W. F. Hamilton, Dublin—Converting circular into parallel motion
2302 L. Dulac, Lille—Drying threads

2303 S. H. Hadley, Hampstead—Decorticating wheat
2304 P. A. Ward and H. Whale, Newington Causeway—Racket bats
2305 C. E. Brooman, Fleet Street—Breech-loading fire-arms.—A com.
2306 T. F., J., C. H., and E. Firth, Heckmondwike—Looms for weaving
2307 H. Fear, Birmingham—Door springs
2308 F. H. Hambleton, Piccadilly—Manufacturing armour plates
2309 W. Dennis, Aldermanbury—Letter pillars

23*rd July*, 1868.

2310 J. Bowron, Newcastle-upon-Tyne, and G. Lunge, South Shields—Iron and steel
2311 A. Buchan, Aberdeen—Ploughs
2312 E. T. Hughes, Chancery Lane—Treating flax.—A com.
2313 W. Gilbert, Birmingham—Lockets
2314 P. Pearson, Leeds—Preparing cocoa
2315 T. Hart, Blackburn—Manufacturing twine
2316 F. Horner, Manchester—Applying copper to the surfaces of inferior metals
2317 W. S. Harrison, Peckham—Constructing timekeepers
2318 M. T. Shaw and T. H. Head, Cannon Street—Lifting and lowering
2319 J. Purdy, Oxford Street—Fire-arms
2320 C. E. Brooman, Fleet Street—Rotary steam engines
2321 J. Kilner, Wakefield—Manufacturing glass
2322 J. S. Bromhead, Peckham, and J. Whitmee, Clerkenwell—Dry gas regulators

24*th July*, 1868.

2323 A. Bochkoltz, Vienna—Self-acting valves
2324 R. G. Hatfield, Chancery Lane—Sliding door rollers
2325 F. H. Danchell, Horwith—Utilizing fuel
2326 N. Barnaby, Lee—Sheathing ships
2327 W. R. Lake, Chancery Lane—Cotton picking machinery.—A com.
2328 G. Smith, Camberwell New Road—Raising fluids
2329 G. A. Thibierge, Versailles—Preserving animal substances
2330 R. Young, Glasgow—Millstones
2331 T. Wrigley and W. E. Yates, Manchester—Looms for weaving
2332 W. E. Gedge, Strand—Feeding steam boilers.—A com.
2333 B. G. George, Hatton Garden—Bronzing printed work
2334 J. H. Johnson, Lincoln's Inn Fields—Iron and steel.—A com.

25*th July*, 1868.

2335 C. Ritchie, Upper Tulse Hill—Portable head dress
2336 J. Young, Milliken Park, R. Pollock and J. Morrison, Paisley—Preventing smoke in furnaces
2337 J. Steel, Glasgow—Cask-washing apparatus
2338 J. Greenhalgh, Oldham—Cleaning cotton
2339 C. E. Brooman, Fleet Street—Drying filamentous matters
2340 C. D. Abel, Chancery Lane—Separating the zinc from the argentiferous alloys obtained in the separation of silver from argentiferous lead
2341 J. Brigham and R. Bickerton, Berwick-on-Tweed—Drill-rollers
2312 A. V. Newton, Chancery Lane—Portable railway.—A com.
2343 L. Wray, Ramsgate—Treating ores
2344 R. Newton, Leeds—Opening and straightening fibres
2345 A. C. M Prince, Trafalgar Square—Bell pull for door bells.—A com.
2346 W. R. Lake, Chancery Lane—Steam boilers.—A com.
2347 A. M. Clark, Chancery Lane—Steering steam vessels.—A com.

27*th July*, 1868.

2348 A. J. Thorman, Lime Street—Obtaining motive power—A com.
2349 J. A. Hogg, Edinburgh—Lamps
2350 G. R. V. Laughton and E. B. Jackson. Paris—Bosses for flax spinning
2351 J. Higgin, Manchester—Printing textile fabrics
2352 J. Lewis, Preston—Consuming smoke
2353 C. J. Laurendeau, Paris—Life-preserving apparatus
2354 H. A. Dufrené, Paris—Indicator of time and distance for vehicles
2355 A. V. Newton, Chancery Lane—Propeller for steam vessels.—A com.
2356 F. Lambe and A. C. Sterry, Surrey, and J. Fordred, Blackheath—Treating vegetable oil
2357 A. M. Clark, Chancery Lane—Artificial ice

28*th July*, 1868.

2358 C. A. M'Curd, Bloomsbury—Sewing machines
2359 W. F. M. Green, Sunbury—Muzzle-loading big guns
2360 W. Lewis, Redditch—Needle wrappers
2361 H. Watts, Water Street—Rails for railways
2362 E. S. T. Steane, Barking—Manufacturing soap
2363 T. Hydes and J. Bennett, Sheffield—Economizing fuel
2364 J. Webster, Birmingham—Manufacturing gas
2365 G. Hodgson, Bradford, H. Bottomley, Low Moor, and E. Cockroft, Odsall Moor—Looms for weaving
2366 J. Bullough, Accrington—Looms for weaving
2367 C. A. La Mont, New York—Preparing eggs
2368 W. R. Lake, Chancery Lane—Manufacturing glue.—A com.
2369 S. M. Martin, Pinner, and S. A. Varley, Holloway—Train intercommunication
2370 A. Morall, Studley—Manufacturing needles

29*th July*, 1868.

2371 J. Onions, Newington Causeway—Ascertaining the number of passengers entering vehicles and the amount of money received by their conductors
2372 J. Simpson, Ardwick—Moulding toothed wheels
2373 T. Winser, Manchester—Sulphate of magnesia
2374 J. Mabson, Norwood—Cinder sifter and shovel combined
2375 E. Herring, Beer Lane—Treating saccharine solutions of malt
2376 W. R. Lake, Chancery Lane—Substitute for linseed oil.—A com.
2377 W. R. Lake, Chancery Lane—Breech-loading fire-arms.—A com.
2378 W. R. Lake, Chancery Lane—Sewing machines.—A com.
2379 A. V. Newton, Chancery Lane—Polishing powder
2380 J. R. Harper, Clerkenwell—Zinc ribbons for telegraphic cables
2381 J. Radcliffe, Consett Hall—Iron and steel
2382 H. O. Robinson, Glasgow—Dredgers
2383 S. C. Lister, Manningham—Cut pile fabrics
2384 J. Jeffreys, Upper Norwood—Preserving animal substances

30*th July*, 1868.

2385 J. Wolstenholme, Radcliffe—Steam-engine pumping valves
2386 G. Woodhouse, Bolton, and J. G. M'Minnies, Farrington—Constructing buildings.
2387 A. Watkins, Covent Garden—Watches and clocks
2388 C. H. Roeckner, Whitchurch—Manufacturing paper
2389 S. C. Lister, Manningham—Manufacturing silk velvets.—A com.
2390 T. H. Roberts and B. C. Cross, Plymouth—Stopping carriages
2391 G. Davies, Lincoln's Inn—Obtaining heliographic plates for printing.—A com.
2392 G. Davies, Lincoln's Inn—Portable batteries.—A com.
2393 J. Duguid, Glasgow—Dressing flour
2394 J. Rawsthorn, Preston—Dressing millstones
2395 J. H. Johnson, Lincoln's Inn Fields—Flame spreader for gas burners.—A com.
2396 T. Prosser, Chancery Lane—Distillation
2397 J. C. Haddan, Vincent square—Manufacturing cannons
2398 J. Gwynne and H. A. Gwynne, Hammersmith—Driving centrifugal pumps
2399 T. C. Fidler Ventnor—Railway rolling stock
2400 C. D. Fox, Spring Gardens—Repairing railway rails.—A com.

31*st July*, 1868.

2401 W. T. Royle, Manchester—Folding paper
2402 F. A. Leigh, Miles Platting—Carding engines
2403 J. Ratcliffe, Little Bolton—Increasing the motive power of steam engines
2404 A. G. Day, Seymour—Substitute for india-rubber
2405 J. F. Lackersteen, Cannon Street—Preserving organic substances
2406 P. N. J. Macables, Paris—Water-feeding apparatus for boilers
2407 B. Sharpe, Hanwell Park—Constructing ships
2408 G. D. Kittoe and P. Brotherhood, Clerkenwell—Cooling fluids
2409 H. Moule, Fordington—Fire-places and furnaces
2410 R. E. Drinhaus, Strand—Treating rheumatism.—A com.
2411 W. W. Symington, Chard—Cutting loaf sugar
2412 A. F. Leale, Soho—Preventing incrustation in boilers
2413 H. Moritz and J. Reinach, Berlin—File-planing machine
2414 H. Moritz and J. Reinach, Berlin—File-cutting machine
2415 G. Harvey, Birmingham—Attaching fronts to shirt collars
2416 A. Taylor, Birmingham—Fastenings for brooches
2417 J. Heaton, Langley Mills—Treating cast iron
2418 J. Heaton, Langley Mills—Producing steel
2419 T. Hunt, Hammersmith—Breech-loading fire-arms

1*st August*, 1868.

2420 J. E. Outridge, Newport—Equilibrium slide valves
2421 C. J. L. Nicholson, Threadneedle Street—Fruit-preserving cans
2422 J. A. M'Kean, Chancery Lane—Eyelet-making machinery.—A com.
2423 M. Samuelson, Hull—Hydraulic press boxes
2424 M. Wilkin and J. Clark, Paddington—Steam boilers and furnaces
2425 A. Arnold, Birmingham—Fastening for buttons
2426 C. Geoghegan, Dublin—Protecting pipes from the effects of frost
2427 G. Wilson, Lossiemouth—Ships' logs
2428 J. Scott, Sheffield—Preparing food for horses
2429 H. O. Robinson, Glasgow—Dredging machines
2430 S. Plimsoll, Sheffield—Unloading railway waggons
2431 J. R. Croskey, Cannon Street—Looms for weaving
2432 L. C. Bailey, Spring Gardens—Drawing pens and compasses
2433 G. N. Shore, Lyme Regis—Railway breaks
2434 G. T. Bousfield, Brixton—Bindings for skirts.—A com.

3*rd August*, 1868.

2435 S. R. Renandin, Strasbourg—"Paraprojectiles"
2436 H. W. Garrett and G. Holcroft, Manchester—Fire-arms and ordnance
2437 C. Wilson, Hull—Reefing and furling sails
2438 T. Ward, Leeds—School desks

4*th August*, 1868.

2439 W. Spence, Quality Court—Treating ores.—A com.
2440 H. A. Bonneville, Paris—Preserving meat.—A com.
2441 H. A. Bonneville, Paris—Dyeing textile fabrics.—A com.
2442 A. L. Hoffman, Poplar—Ships' yards
2443 R. Schomburg, London Street—Manufacturing bricks
2444 B. J. B. Mills, Southampton Buildings—Harvesting machines.—A com.
2445 C. F. C. Cretin, Glasgow—Lamps
2446 E. Evans, Gresford—Mills for grinding wheat
2447 J. Frazer and W. Naar, Bayswater—Mattresses
2448 A. V. Newton, Chancery Lane—Boots and shoes.—A com.
2449 T. W. Kitson and P. Chalas, Leeds—Friction clutches
2450 C. G. Johnson, Stockton-on-Tees—Making bricks

5*th August*, 1868.

2451 J. Hamilton, Chancery Lane—Artificial fuel
2452 T. R. Oswald, Sunderland—Constructing ships
2453 A. V. Newton, Chancery Lane—Iron and steel.—A com.
2454 M. D. Spartali, Liverpool—Propelling vessels

6*th August*, 1868.

2455 W. Millard, Trowbridge—Looms
2456 H. Churchman, Horsham—Boots and shoes
2457 E. Edwards, Westminster—Pumps
2458 M. Benson, Manchester Square—Safety valves.—A com.
2459 L. Price, Birmingham—Candlesticks
2460 W. Pearson, W. Spurr, and H. Bradbury, Bristol—Looms
2461 J. Hargreaves, Darlington—Iron and steel
2462 H. F. Freutel, Kingsland, and H. Zox, Blackfriars—Hats
2463 A. M. Clark, Chancery Lane—Scissors.—A com.
2464 W. and E. M. Hann, Hetton Colliery—Safety lamps
2465 W. R. Lake, Chancery Lane—Felted fabrics.—A com.
2466 A. V. Newton, Chancery Lane—Boots and shoes.—A com.
2467 W. M. Moore, Dublin—Paper holders

7*th August*, 1868.

2168 T. W. Stapleton, Regent Street—Fire-arms
2469 C. J. Curtis and A. Fiddes, Bristol—Safes
2470 G. W. Maddick, Holloway—Forks and spoons
2471 B. Hunt, Lincoln's Inn—India-rubber fabrics.—A com.
2472 J. Whitehead, Manchester—Manufacture of paper.—A com.
2473 N. Salamon, Ludgate Hill—Sewing machines.—A com.
2474 H. Benjamin, Abbey Road—Washing machines
2475 J. Litchfield, Nottingham—Lace fabrics
2476 W. E. Newton, Chancery Lane—Regulating the speed of machinery.—A com.
2477 G. Leach, Leeds—Carding wool
2478 W. E. Newton, Chancery Lane—Fire-arms.—A com.
2479 J. Arnold, Sheffield—Steam boilers

8*th August*, 1868.

2480 S. Gardner, Neath—Annealing pots
2481 J. Broadfoot, Glasgow—Water-closets
2482 B. Hunt, Lincoln's Inn—Blind furniture.—A com.
2483 J. Kirk, Woolwich, and J. Batestone, Westminster—Protecting fortifications
2484 J. Standen, Borough—Multitubular boilers
2485 A. V. Newton, Chancery Lane—Steam engine governors.—A com.
2486 W. E. Newton, Chancery Lane—Screw drivers.—A com.
2487 D. Nickols, Manchester—Cocks
2488 H. Dubs, Glasgow—Combined steam crane and locomotive engine
2489 T. Walton, Staines—Treating gums
2490 J. Hird, Bristol—Obtaining motive power

10*th August*, 1868.

2491 T. Kenyon, Manchester—Sulphuric acid
2492 F. Le Roy, Commercial Road—A non-conducting composition
2493 T. Corfield, Falmouth—Self-sealing paper bags.—A com.
2494 B. Hunt, Lincoln's Inn—Eyelet-making machines.—A com.
2495 B. Hellwag, Greenock—Telegraphing on board ships
2496 W. W. Hughes, Porchester Terrace—Fans
2497 A. V. Newton, Chancery Lane—Automatic indicators for boilers.—A com.
2498 D. Freewirth, Norwood, and A. Hawkins, Camberwell—Producing raised printing surfaces

SAFETY CAGES AND LIFTS.

MESSRS MERRICK & SONS. PHILADELPHIA. U.S.A.
Patentees.

Fig. 1.

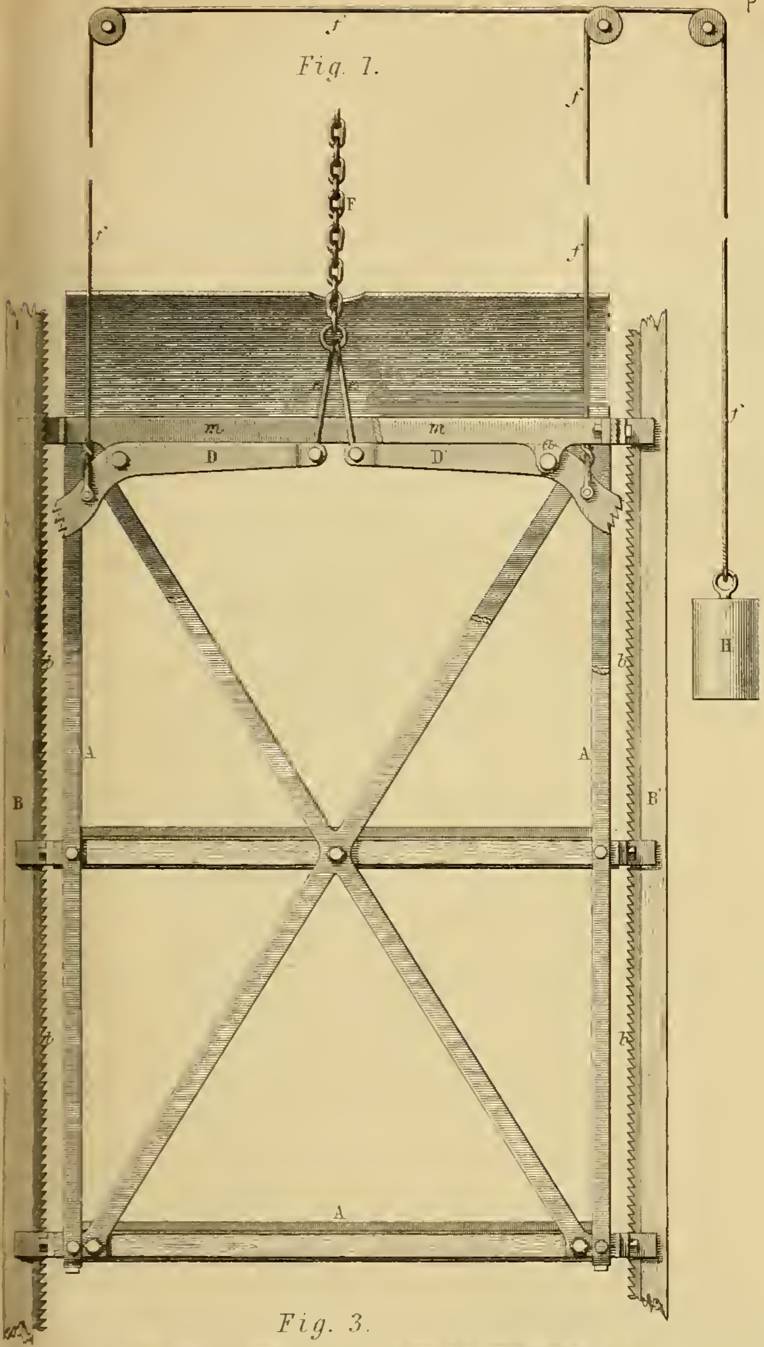


Fig. 2.

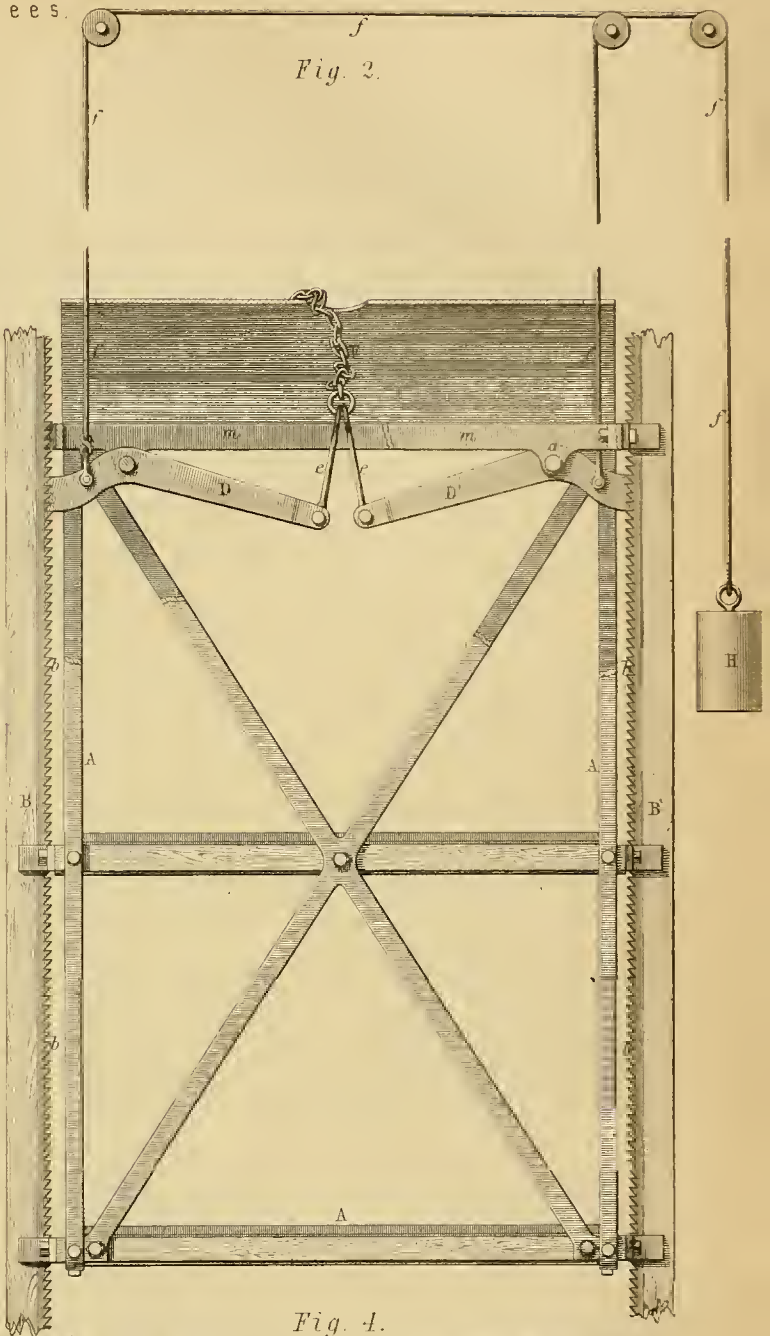


Fig. 3.

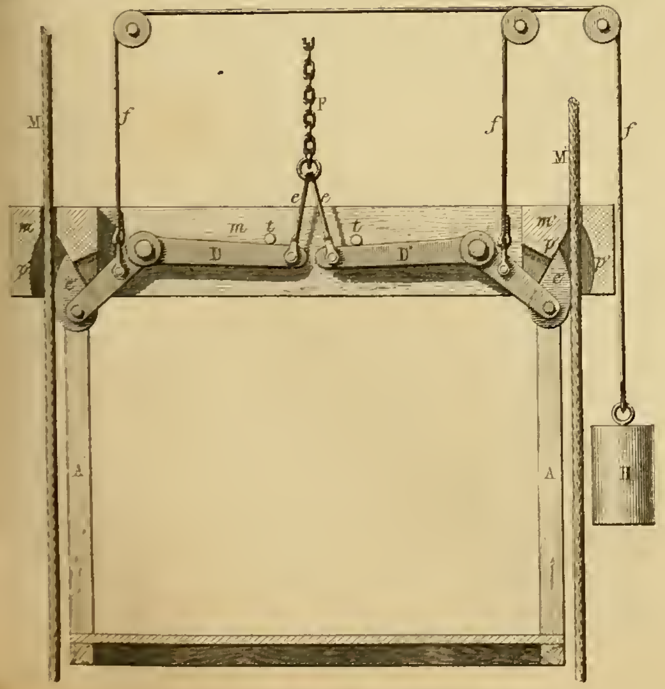
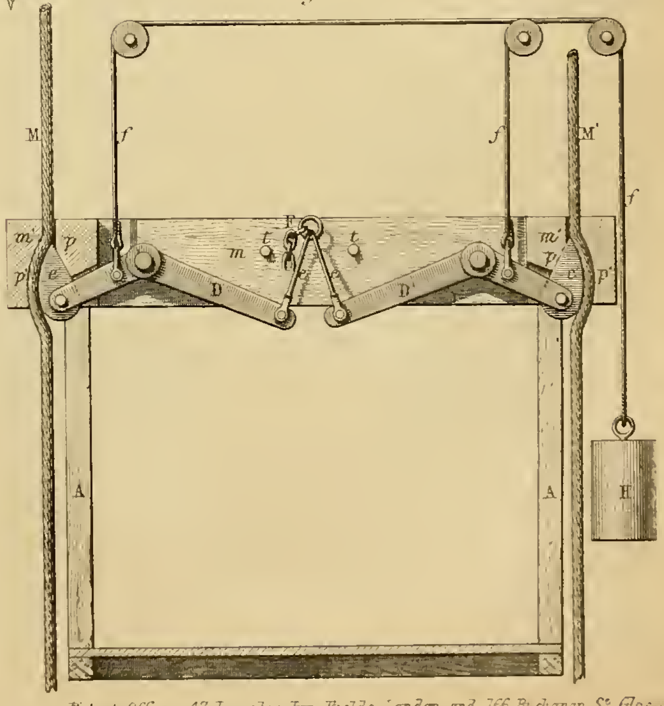
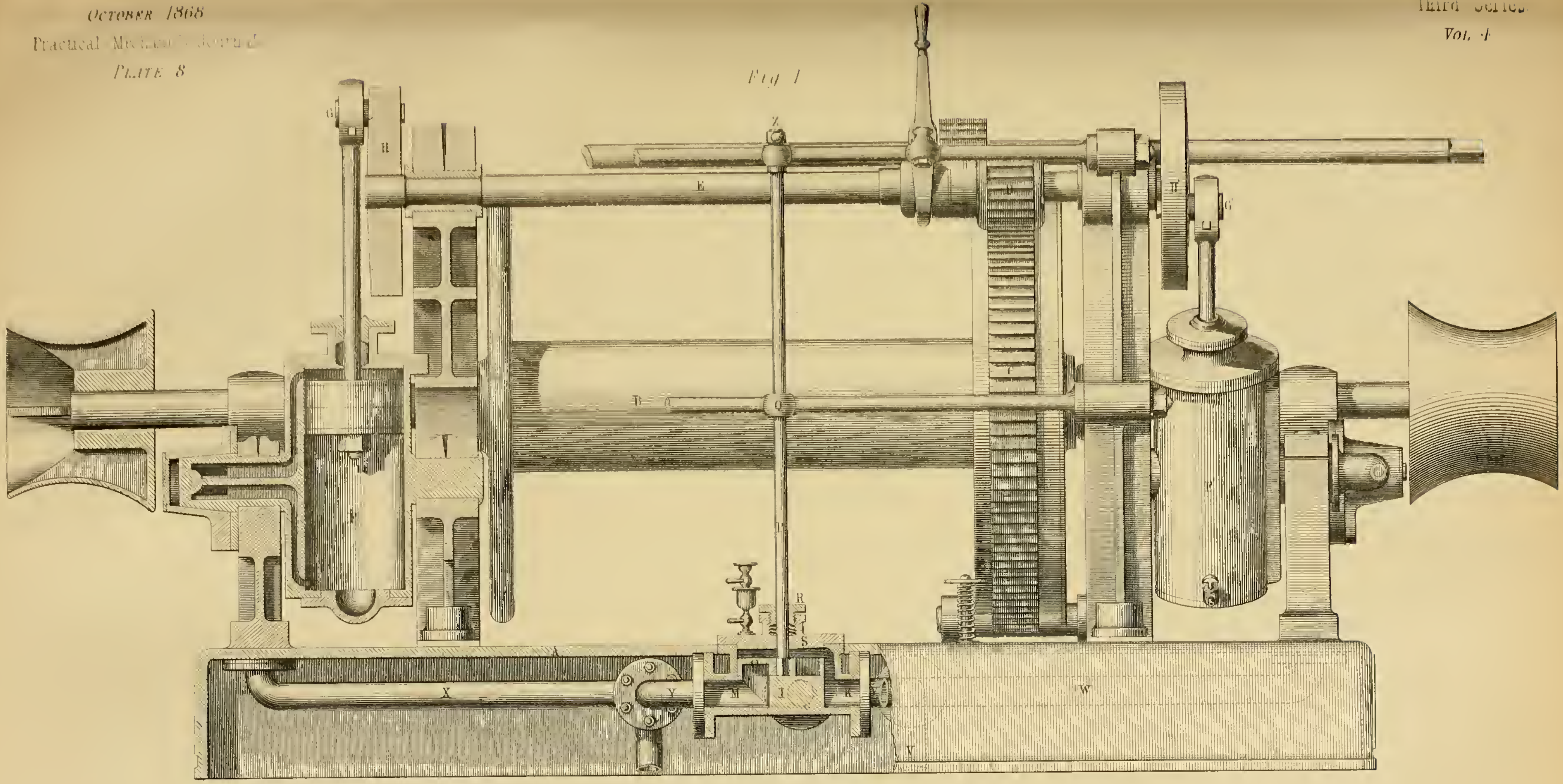


Fig. 4.



Patent Offices. 47 Lincolns Inn Fields London, and 166 Buchanan St Glas



CORRADI'S PATENT STEAM WINCH.

MESSRS OSWALD & CO, SUNDERLAND,
Manufacturers.

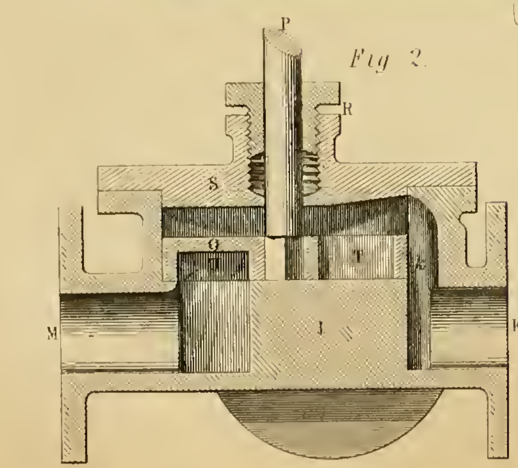


Fig 2.

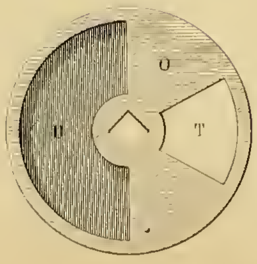


Fig. 4.

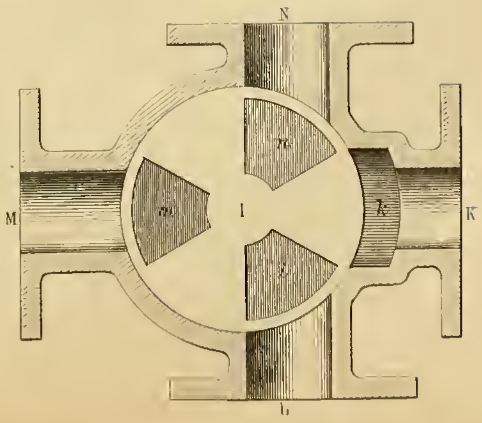


Fig. 3

Patent Offices 47 Lincolns Inn Fields London and 166 Buchanan St Glasgow

BOILER-PLATE BALLOON BUILDING.

No. II.

To those curious in the history of ballooning, and of all that directly or indirectly relates to it, even including Elijah's "horses and chariots of fire," we commend Mr. Turnor's strange book, with the notice of which we concluded our last paper. However, we must now return to our text—Boiler-plate balloons. Is there anything more absurd in such a notion than in that of building an iron ship? John Scott Russell, in his great book on shipbuilding, tells of a shipbuilder of the old school who in his hearing declared he would never build a ship of iron—"it was against nature;" and in a sense it is so. A cubic foot of solid fir or oak thrown into the water floats; a cubic foot of wrought iron, weighing 480 lbs., while the cubic foot of water it displaces weighs but 62 lbs., goes to the bottom, "according to nature." But if we spread out the cubic foot of iron into a sheet of about $\frac{6}{10}$ths of an inch thick, and make of this an open rectangular box of 2 feet square and nearly 2 feet in depth, we shall find that it will float in fresh water immersed to just about the level of the brim, and equally according to nature. And, further, if we rolled down the cubic foot of iron to $\frac{3}{10}$ths of an inch in thickness, and made the box of the same size, we should find the iron would not only float but carry a cargo of about 240 lbs., or a man and a boy. Is there any reason why the same principle taken in another direction should not apply to floating in air as well as to floating in water, and equally according to nature? If our balloons of whatever form be similar, their surfaces will be as the squares, and their contents as the cubes, of any homologous dimensions. Suppose them spherical: then if a sphere of some material not weighing more than half a pound per square yard, of six yards' diameter, will just suffice to carry up one man of 140 lbs., which is about the fact, then five, ten, twenty, and one hundred men will be carried up by like spheres of the following dimensions:—

1	5	10	20	100 men.
6	10·2	12·9	16·2	27·8 yds. diam.

But the carrying power, relatively as well as absolutely, increases immensely with the size, because the surfaces of the spheres are only as D^2, or—

1	5	10	20	100 men.
113·0	326·7	522·5	824·1	2426·7 square yards.

So that, although we have in the last a balloon of *one hundred* times the carrying power of the first, we have its total weight, if made of like material, less than twenty-one and a half times that of the first.

Again, the resistances opposed by these several spheres to the wind moving against them, or that to be overcome by their moving against it, are as their great circles, or as D^2, or as the numbers following:—

1	5	10	20	100 men.
28·3	81·7	130·7	206·2	606·9

So that, while the carrying capacity has increased one hundred fold, the aerial resistance has only increased about twenty-one and a half times, as in the case of the total surfaces.

It is thus obvious that if we only continue to increase the diameter of our balloons we can arrive at a size at which we may make the balloon itself of any material we please, and as thick and heavy as we please. It is only continuing the same process by which the illustrative cube of iron was made to float and carry a burden in water—it is but the iron ship, in fact, in another element; and so we come to the boiler-plate balloon. But why of boiler plate? All needless weight in the balloon is so much waste of ascensive power, just as too great weight in the iron ship is waste of propulsive power, useless draught of water, and loss of cargo-carrying power. If balloons made of stout varnished silk are found sufficiently strong, why depart from it in favour of some heavier material? For two reasons: first, no tissue, however firm, dense, and well varnished, can be employed for a balloon without continual loss of gas, whether that be hydrogen or light coal gas, by *exosmosis* through the tissue; second, no flabby, flexible bag with a pendulous car dependent from it, can ever be made a *point d'appui* for power such as must be employed if a balloon is ever to be moved by anything except its own levity or the contrary, or swept along before the winds.

We come, therefore, to *a gas-impervious shell, and to a shell stiff enough to form a basis for what power is to act upon it*, as things to be held in view from the outset of any inquiry as to what we can do with a big balloon, if anything!

Now it is a remarkable fact in the history of ballooning, that two of the very earliest speculators and writers on the subject should have, respectively, got a good way towards discerning clearly these conditions, and even something beyond. Father Lana, a Jesuit of northern Italy, in 1670 published at Brescia in a very remarkable book, entitled "Prodromo dell' Arte Maestro," amongst much other curious matter, his project for what has been called his "philosophical vessel," or ship of the air. The project consisted in securing symmetrically to and above a light car or boat four large and thin copper spheres, which he proposed to exhaust absolutely of air by means of water and the Torricellian tube, then a novelty to science. His notion was that, provided the weight of each sphere of copper was considerably less than that of the air taken out from its interior, it must ascend; and so far he was perfectly right, and his reasoning just. His practical notions of construction, however, were wild and crude enough. He thought that four spheres of 25 feet diameter might be formed of copper, not more than $\frac{1}{200}$th of an inch in thickness, and so mathematically perfect in form that the external pressure of the air, when they should be exhausted, should be all resolved tangentially, and resisted by the thin shell of copper.

Hooke, Leibnitz, Sturm, and Borelli, and others in later times, have examined this project, and been very lively in their exposure of the poor Jesuit's ignorance, and at his expense. Lana no doubt proposed what, according to his own data, was absurd, and could not be practically carried out. But he was not only generally right in theory, but he actually saw with clearness what has escaped the sagacity of almost all modern aeronauts, that the most perfect of all balloons, if we could obtain it, would be one which should contain nothing at all.

It was not until 1766 that our own Cavendish discovered hydrogen, and Lana knew nothing of gases lighter than air under equal tension and volume; so that he did not see any mode by which he could get rid of the vacuum in his air-tight copper spheres, nor hence have speculated on the substitution of flexible bags in place of the copper, in which case he would have anticipated the gas balloon; and by consequence he did not discern any other advantage in a metallic balloon than that it gave him, as he supposed, the power of obtaining by it the levity due to its emptiness. Others, however, since the nature of gases and the laws of their diffusion through membranes have been known, have seen the advantages that Lana's construction might afford, that a metallic, and so impervious envelope, would, if procurable, be the best possible.

In 1844 Monges, at Paris, is said to have constructed a balloon of copper foil $\frac{1}{200}$ of an inch thickness, which was 30 feet in diameter, and stated to have weighed 300 lbs. There must be some mistake about the thickness or the diameter, however; for a sphere of 30 feet of this thickness of copper would have weighed 640 lbs. or thereabouts, and a globe of that diameter, if filled with dry hydrogen, would have only raised 57 lbs., assuming the sphere without any weight itself.

We need not discuss the incorrect data copied into one book after another in this, as usual in so many cases; it is sufficient here for us that Monges seems to have seen the possibility and desirability of making an impermeable balloon with a metallic envelope. We may remark in passing, however, that what may perhaps at once occur to the reader, namely, to effect this by gilding over with Dutch gold, or with silver leaf, the surface of a silk balloon, is erroneous, and would not answer the end in view. Gold, silver, and Dutch metal, are all so full of holes as to be as permeable to gases as a sieve. If impermeability is to be secured (and without that a balloon for any conceivable useful end can be no more "air-worthy" than a leaky ship is sea-worthy), it can only be secured by an inflexible envelope of rolled metal, sufficiently thick to be as gas-tight as a common gasometer. The merit of being the first, if not to see this, at least to express it in print, appears to belong to M. Depuis Delcour; the passage, as quoted by Mr. Turnor, is as follows:—"A guidable aerostadt can be made, but then it should be ship-like, with wood and metal in its construction, involving a serious attempt for which money is required; the value of one iron-clad, if spent upon a proper course of experiments, might have decided the form and construction of a serviceable aerostadt, and the stake to be won is far greater than the cost would be."

Depuis Delcour has classified and tabulated all the multitudinous schemes that all the *tête à l'air* inventors have produced for guiding and navigating balloons. These he reduces to fourteen classes; the proposals of nearly every one of which he pronounces impracticable.

Three intelligible propositions have been made as to compelling balloons to move through the air. The earliest is due to Cardan, who remarks that a rocket is in reality a flying machine, which is enabled to carry its own power, and the means for the guidance of the direction of motion, and suggests that fire, acting as in a rocket, might be made the means of flying generally. The total weight of a 24-pounder Congreve rocket and stick is about 29½ lbs., of which the stick weighs 8⅓ lbs., and the case, stem, &c., not far short of 8 or 10 lbs. more. About 11 lbs. of rocket composition in this rocket is sufficient to carry the rocket, stick, and composition, when fired at about 45°, something about 3400 yards. As we do not know accurately either the height in the trajectory to which the rocket rises, nor the time of flight, we are unable to calculate the work in foot-pounds developed; but we see plainly the largeness of the work done, even in this wasteful way of applying the reaction of the issuing gases, in carrying nearly 30 lbs. at a rate to develop a powerful resistance from the air, to a distance of nearly 2 miles, and rising in the air, perhaps, 800 or 1000 yards, within possibly not more than 40 to 50 seconds.

Mons. Nadar, of Parisian popular science and aeronautic celebrity, seems to have been the great advocate of the applicability of the screw-propeller to balloons, although the original hint of the power of the screw to act upon the air, conversely, as the wind acts upon the vanes of a windmill, seems to have been given by Pancton, a French mechanician, in 1768. The effects obtainable from the air screw-propeller or helix have been the subject of modern investigation, by Nadar himself, by De Landelle, D'Amencourt, Barral, and Babinet. The relation between work expended and work done in air by this helix seems to depend greatly upon the velocity of revolution, a matter quite to have been expected. As yet no experimental data are in existence, so far as our knowledge extends, upon which any safe calculation might be based as to what propulsive effect can be thus developed from a horse-power. But that the maximum possible "duty" would be considerable is put beyond doubt by what any one may witness in the common French toy of a four-bladed helix of tinplate, with a vertical hollow axis, which being made suddenly to rotate rapidly by means of unwinding a cord, like that of the common "humming top," mounts into the air to a considerable height.

One of these toys has been made, which, though of no great size nor rotated by other power than a man's arm, was enabled to rise to more than the full height of the spire of the cathedral at Antwerp, and to be carried by the wind clean over that. The air-helix does, in fact, appear to present the best intermediate instrument for acting upon the air by power, when we shall, if ever, have secured that.

The third proposition as to directing balloons, to which we have referred, is different in character from the two preceding. It refers to enabling the aerostadt to ascend and descend without loss of gas, by compressing into a close vessel, by mechanical power, a portion of the gas with which it is filled, or *vice versa*, again letting that back into the balloon.

This notion appears to have occurred to General Meusnier, and is found in his work of 1785, but remained with little attention until M. Marey Monges, in 1847, recalled attention to it. This method is of course only applicable, in the form described, to a flexible balloon—one of the ordinary material. But the *principle* is applicable in another way with a rigid balloon of metal; for although that must always remain full of the gas with which it is once filled, the external atmosphere may be pumped into a close vessel, so as to add to the weight of the system, or again let forth by its elasticity, just as water is let in or expelled from a nautilus diving bell to alter the specific gravity of its system. This method, always again assuming that we can find the power requisite to work it, does appear to afford the means of descent and ascent, or rather of vertical translation without permanent loss of anything but power.

We come, then, to this, that if ever we are to do any good with ballooning we must discard all notions of movement by animal, or at least human power, whether that is applied to propel a balloon or directly to flying; that we must provide the means of ascending and floating in the air by means of a rigid metallic envelope of some sort, which shall hold gas indefinitely long without loss, and which shall contain within its contours, or else have in rigid connection with it, the power which is to act upon the air for the purpose of laterally, or perhaps also vertically, propelling the whole system: for as regards vertical movements, they may be effected either by direct propulsion or by means of condensation or expulsion of atmospheric air, as just described, and the choice lies in favour mainly of that which shall consume least power in reference to work done.

We must, then, have a rigid, permanently gas-tight balloon; it must be abundant in carrying power, if by any means we are to get sufficient power for propulsion, and which we must carry with us; and our propulsive power and machinery must be ample, if we are to have any real control over the huge machine which our balloon must inevitably thus become. Our source of power must be the lightest and most compact that the limits set by the nature of structural materials and the forces of nature at our command can permit, and the power must be developed in such way as shall reduce the amount of fuel or other consumable material as the source of power to a minimum. Such are the bases upon which any rational investigator as to aerial navigation must proceed. As to the best form for the aerostadt, so as to give the most manageability and least aerial resistance—convenience for the other conditions demandable—those are all secondary considerations, and were the main points once solved, the latter would present few difficulties.

Based upon the experiments of Newton as to the fall of glass globes in air, and those of the French military commission of Metz, in 1836, the following formula represents, with approximate accuracy, the resistances of spherical bodies moving in still air, at velocities between 1, and about 32½ feet per second; or conversely, the work that must be expended to cause the sphere to move against the air at the same rate:—

$$R = 0{\cdot}0375 \frac{D^2}{1{\cdot}273} V^2$$

giving the resistance, R, in kilogrammes. Now in the example we before gave of a balloon of 18 feet diameter, to carry up one man, the work required for its propulsion at the following rates will be approximately thus—

3 feet per second	=	1·86 miles per hour.	6·57 foot-pounds per second.
6 " "	=	3·71 " "	52·46 " "
9 " "	=	5·57 " "	177 42 " "
12 " "	=	7·42 " "	420·78 " "
16 " "	=	10· 9 " "	821·32 " "

This, we may remark in passing, disposes of the question of propulsion by human power. For as a man cannot continue to develop more than about 59 or 60 foot-pounds per second, it is obvious that all he could do would scarcely force his balloon, just supporting itself and himself, at the rate of one yard per second against a wind blowing at the same rate, a result which, we may remark, much exceeds what General Meusnier calculated was the limit of velocity thus attainable, viz., 1·11 metres per second in still air. Nor will it help very materially if we should make the balloon as big as to carry 100 men, viz., 27·8 yards diameter, for if we apply the same formula we shall find the total work to be developed for the same greatest velocity as above (16 feet) will be about 34 5 foot-pounds per second per man. A pleasant breeze moves at the rate of nearly double the above velocity; but aerial ships must be competent to navigate aerial storms.

Let us try to see what we can do with an iron or steel plate balloon. A cubic foot of dry air weighs 536·959 grains, the same volume of light coal gas (sp. gr. 0·300) 161·084 grains, and a cubic foot of dry hydrogen 36·980 grains, all these being at mean temperature, barometric pressure. The ascensive power due to a cubic yard of hydrogen is therefore, at the earth's surface, 1·93 lb., and that due to coal gas 1·45 lb. But as a balloon must clear ordinary ranges of hills, &c., or must ascend, say at least 2000 to 3000 feet above the earth, we must allow for the rarefaction of the air above, and so we may take 1·75 lb. per cubic yard of gas as a mean coefficient for ascensive force, as referred to the capacity of the balloon.

Now let us suppose a sphere made of steel plates of 170 yards or 510 feet diameter. It may possibly be admitted that such a sphere could be constructed by making the lowermost segments of the sphere first, and then launching that saucer upon still water, and so building up the remainder piecemeal upon this, resting upon its cushion of water, until the entire sphere was closed in at top—and it may, perhaps, be further admitted that it would be possible to construct it of sheets of steel whose *average* thickness all over should not exceed ⅛th of an inch;

the plates at the bottom part being thicker, and gradually thinning towards the top, until they would be as thin thereabouts as it would be practicable to make the seams gas-tight. By help of some sort of soldering, with rivets, perhaps, the uppermost fourth of the spherical surface might be made not more than $\frac{1}{50}$th of an inch thick. However amenable to objection as to actual practicability, the possibility of constructing a sphere of 510 feet diameter of steel plates not *averaging* more than $\frac{1}{8}$th inch in thickness, we shall here assume.

The surface of this globe we shall find under 817,000 superficial feet, and its cubic contents to be 69,376,000 and some odd cubic feet, and the weight of the shell to be about 1915 tons, allowing $\frac{1}{20}$th for laps, &c. With the above coefficient of ascensive power then, the total ascensive effort of the included gas would be about 2004 tons. Taking from which the weight of the spherical shell of steel, we find it would have an available ascensive power of $2004 - 1915 = 89$ tons. Such a sphere could therefore carry itself up with 9 tons of passengers, their luggage and provisions, &c., and allow, say, about 70 tons to be devoted to propulsive machinery of some sort. That available burden (we may talk of the burden of a balloon as well as of a ship), large as it is, would perhaps prove quite inadequate to enable any machinery to be applied to the globe capable of controlling its motions.

Perhaps the only conceivable way in which such a sphere could be directed at all, supposing the machinery itself obtained, would be to construct three very large cylindrical tubes, also of plate steel, intersecting each other in their axes at the centre of the sphere, and placed at right angles to each other, two being horizontal and one vertical; and we may assume, in each of these tubes, an air helix or screw propeller fixed, and acted on by some sufficient motor, with the power of moving any one or any two together of these screws, at pleasure. Motion in any required direction would thus result. We may suppose superadded the machinery for pumping in and condensing air, and evolving it again as ballast, in the way before referred to. For our 510 feet diameter balloon these tubes might possibly be about 30 feet diameter each, and so would weigh, if of steel of 3·5 lbs. per superficial foot, about 240 tons, and would at the same time take away rather more than a million of cubic feet from the capacity for gas of the sphere. So that, with these supposed adjuncts, we see that even this great sphere is below the limits at which we could make it ascend with machinery to move it.

Let us then further extend it, and suppose a sphere of 1020 feet diameter, intersected by the three 30 feet tubes, to be constructed of steel plates thicker than those above taken, in the ratio of 3 : 2. Then, as the surfaces and solidities of spheres are as D^2 and D^3 respectively, we shall here have 3216 tons $\times D^2$ for the weight, and 1776 tons $\times D^3$ for the total ascensive power; but the diameters here are as 2 : 1, therefore $1976 \times 2^3 = 1976 \times 8 = 15808$ tons is the total ascensive effort, and $3216 \times 2^2 = 3216 \times 4 = 12869$ tons for the total weight of sphere and tubes. There would, therefore, be an available ascensive power of no less than 2939 tons, which certainly affords a good deal of cutting for cargo and machinery, and would still do so, even if we suppose that we were to add the odd 939 tons in steel, &c., to the strengthening of the hull and tubes of our imaginary globular aerial ship.

Now let us see what it will require to drive it, supposing it in the air, and that perfectly still. We found before that at 10·9 miles per hour, a balloon of 18 feet diameter had an aerial resistance requiring 821 foot-pounds per second to overcome it. Assuming that the law of resistance to so enormous a sphere as one of 1020 feet diameter would remain the same as with so small a one, and employing the same formula, we find that to force this huge balloon against the air, supposed still, at the same rate, 10·9 miles per hour, which is about the rate of the Peninsular and Oriental steam ships, would require 4738 horse-power. So far then, a balloon that should be permanently gas-tight, or that when once filled would need but little after supply to meet leakage, which should contain within its rigid shell all its cargo and the machinery to propel it, may be admitted as proved theoretically possible. With 2000 tons of carrying power even high pressure steam engines might conceivably supply the power above seen to be requisite; but Carré's ammonia engine—gas engines working from hydrocarbon gases, liquefied under pressure and extreme cold—or the slow and regulated combustion of carbazotic ammonia gunpowder, or of gun cotton, and the evolved gases acting upon pistons and cylinders, &c., all offer the tolerably well assured future means of procuring power to any extent (expense aside) with immeasurably less weight in engines and *pabulum* (we can scarcely call it fuel) than by any form of steam engine. We see enough, from the above rough way of treating these questions, to satisfy ourselves that in fact a sphere of greatly *less* than 1020 feet diameter—one not *very* much greater than the first example of 510 feet diameter—would, in fact, meet all the theoretic requirements of the case, provided we could secure our motor of greatly less weight than the lightest steam engine of equal power in working trim.

An aerial globular ship, such as we have shadowed out, would of course maintain its position of stability by the aid of ballast at the lower part of the sphere, which should be obtained by arranging suitably the position of the machinery. It would be necessary to secure its descent into water always, and ascent from it, as within the limits of theoretically possible strength the globe would not bear its own weight resting upon any hard body like the surface of the earth. But we forbear from pursuing into any detail further that which we warn our readers they are not to view as a project at all, nor anything more than an example brought from the realms of imagination, for the purpose of giving some clearness to our mechanical and other readers upon those questions of the possibilities or impossibilities of aerial navigation, which we all hear so frequently and so vaguely and often erroneously discussed.—Ed.

ON THE CHEMICAL HISTORY AND REACTIONS INVOLVED IN THE FORMATION AND IN THE SETTING AND HARDENING OF PORTLAND AND OTHER CEMENTS OF THE LIKE CLASS.

(*Continued from page* 170.)

In the comprehensive work of W. Heldt that author considers also the formation of a lime aluminate as of great importance. The lime aluminates well powdered and mixed with little water, get nearly instantaneously hard, and produce hydrates, which acquire in water a great hardness, and also unite well with chemically inert substances, such as quartz, &c. The higher the temperature under which lime and alumina are melted together, the harder the lime aluminates become on their mixture with water. Oxide of iron produces combinations with lime similar to those it forms with alumina. The affinity between lime and alumina is, according to Heldt, greater than between lime and silica, when these are exposed to fire. Silicate of alumina is dissolved by lime with formation of aluminous or clay lime; and the silicic acid getting free in consequence of this formation, unites with the excess of lime and forms a basic compound, which at first takes up the water, and unites afterwards during the hardening with the lime hydrate, which has separated from the lime aluminate at the contact with the water.* In this medium of lime hydrate the hard silicate compound of lime is formed, while the alumina hydrate remains without effect distributed in the mass. The addition of from 1 to 2 per cent. of alkali to the Portland cement is very important; for by its solution in water the alkalic medium which favours the hardening is produced, and it promotes besides, during the burning, the fine division of the clay, to which it stands nearer in affinity than the lime. The taking up of water, especially with Portland cement, lasts for two or three weeks, after which time a cessation takes place. Afterwards the carbonates, which may be contained in the water, dissolve the silicates, producing carbonate of lime, and there separates at length actual silicic acid, by which, after the drying, the loose particles are still more cemented and indurated. Of course this slow process takes place chiefly on the outside. Prince Schönaich Carolath treats also, in the *Zeitschrift fur Berg-Hütten und Salinenwesen*, on the theory of Portland cement, and referring to the works of Fuchs, Feichtinger, and Pettenkofer, agrees in the main with the opinion of the latter investigators. Practical experiments, which he had the opportunity to perform with different materials from Silesia (fresh-water lime and septaria clays), and in which he used two different sorts of clays for mixture, gave occasion for his observations. He got, indeed, in both cases, quick and perfect hardening cements, but a mass as compact as good Portland cement was produced only when he used a clay from Kieferstädtel, in Upper Silesia, which is a similar compound to the clays of the Medway river, or those from Wildau, near Neustadt-Eberswalde. The composition of these clays must, according to the results of these investigations, be as follows:—

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* It requires further examination to prove whether the separation, observed by *Winkler* and herewith confirmed, only originates from lime aluminates, or whether unchanged lime surrounded by coagulated silicates, as taken by *Feichtinger*, also exists. Certainly there exists a combination between puzzolane or like silicates and lime, and is the reason of the hardening and the getting free, which only after some time takes place (according to *Heldt* the lime is here *in statu nascendi*); or the separation of the lime (according to *Feichtinger*) is a particularity of the Portland cement.

From	60	to	70	per cent.	of	silicic acid.
"	10	"	20	"		alumina.
"	10	"	15	"		oxide of iron.
"	4	"	6	"		alkalies.

Incipient fusion must take place at a temperature at which the carbonic acid of the included lime is driven off; this gas, with formation of blisters, raises or disintegrates, so to say, the clay particles already melted around and amongst the particles of the lime. During the subsequent cooling the particles of the produced caustic lime are surrounded with a glassy crust, in such a manner that the cement is produced in the form of blistered, porous, slag-like, stony masses. If the temperature is raised higher, or the clay itself contains a large proportion of chemically combined calcareous earth without carbonic acid, the formation occurs of a lime silicate (which very often falls on cooling into a fine powder, and which with water will not harden) during the burning. If, however, separation of the carbonate of lime and a complete and uniform scorification have not yet taken place, a complete melting even of the clay is not disadvantageous; on the contrary, the escape of the carbonic acid, after the melting of the clay, is a principal condition for the foliated (pulverulent?) structure of the particles of a good cement, whereby the density after the hardening is accelerated, and the slower the caustic lime, covered with the silicate, slacks, the more can the cement absorb water, and the formed silicates become soluble. The absorption of the water, which, therefore, in a good cement takes place without any perceptible indication, must set in slowly, in order to give to the different *couches* of the mass time for adjusting their mutual positions in relation to each other. In a quick-setting cement (which also heats in setting more considerably) the lime particles are less surrounded with slaggy or glassy materials, and the cement reaches only a good degree of hardness after its absorption of carbonic acid.

Amongst the principal requirements of clay suited for the manufacture of cement, their containing oxide of iron is not essential; but silicates of the protoxide of iron are essential, for only the latter have the required degree of easy fusibility, which prevents or renders difficult the introduction of the calcareous earth into the silicates produced during the burning. A proof of this appears to be found in the spontaneous and, as to the quality of the cement, injurious decomposition of the Medway clay, where the protoxide changes into oxide and sulphuret of iron, which, undecomposed, are taken up by the silicates and accelerate their fusibility. After long periods the iron salts change into carbonates, which, combining with the lime added, form difficultly fusible silicates of oxide of iron.

Returning now to the work of Michaelis: he opposes at first also the hypothesis laid down by Pasley and Schafbäutl respecting the importance of the degree of oxidation of the iron, and asserts, on the grounds of many experiments, that, as there exists in the burnt cement only peroxide of iron, it is probably unimportant whether the Medway clays be weathered or long exposed to the air or not.

The cement clays contain all far more silicic acid (in 2 [$Al_2 O_3 Fe_2 O_3$] from 6 to 11 equivalents of $Si O_2$) than the real kaolins or porcelain clays, which are $2 Al_2 O_3, 3 Si O_2 + 4 H O$, or in normal composition per cent:—

Silicic acid,	39·96
Alumina,	44·46
Water,	15 58
	100·00

For the Portland cements the following stöchiometric proportions are the limits:—

$60 Si O_2$	to	$80 Si O_2$.
$210 Ca O$	"	$230 Ca O$.
$27 Al_2 O_3 (Fe_2 O_3)$	"	$15 Al_2 O_3 (Fe_2 O_3.)$

or if $Si O_2$ and $Al_2 O_3$ are taken as equivalents, $10 Si O_2 (R_2 O_3) + 20 Ca O$, to $10 Si O_2 (R_2 O_3) + 24 Ca O$.

As regards the process of induration the following facts are of importance:—

1. Lime with soluble silicic acid forms true combinations which harden under water. Fuchs got $4 Ca O, 3 Si O_2$, thus in combination by mixing both substances; Heldt got from water-glass and $Ca O, H O$, the compound $5 Ca O, 3 Si O_2 + 5 H O$; Michaelis got, by mixing water-glass and lime, preserved while combining free from access of carbonic acid, a combination $5 Ca O, 2 Si O_2$, which was equal to calcareous spar in hardness and strength.

2. Lime, when powerfully heated with alumina, as, previously to Heldt and Fremy, had already been observed by Sefströms and Winkler, and as also Michaelis proves, forms combinations which harden under water. The hydraulicity of these compounds increases with the high temperature at which they are burned.

3. Silicic acid and magnesia likewise harden, according to Deville, (*Comptes Rendus*, 1861) perfectly; but this reaction has no relation with the setting and induration of Portland cement, although it has direct reference to certain hydraulic limes produced from dolomitic limestones.

4. In hardening, these limes and magnesia compounds withdraw all the silicic acid from solutions of alkaline silicates.

5. Cements (Portland and its analogues) are soluble in water free from carbonic acid.—(*Gunning*, *Feichtinger*.) Michaelis thus dissolved in seventeen days 86 per cent. of Portland cement with 20,000 volumes water. In practice, it is only the dense mass of the cement on the one side, and the carbonic acid contained in all natural waters on the other, which preserves at first such cement from disintegration and washing away. But the formation speedily of carbonate of lime and the silicic acid separated from the alkaline silicates, cement the mass together, and prevent the further absorption of carbonic acid and water so completely, that even in cement blocks hardened for many years, Michaelis found that carbonic acid had only penetrated their mass to the depth of a few millimetres. He asserts, in contradiction to Feichtinger, that the action of carbonic acid does not increase the hardening, and that Portland cement will get just as hard without its access.

6. In practice, the cement is mixed with from 40 to 50 per cent. of water. If protected from carbonic acid it contains, after hardening, from 14 to 16 per cent. of water. Desiccated in a glass bell over chloride of calcium the experimental samples of hardened cement, which in the mixing of 100 parts had consumed from 36 to 43 parts of water, and then contained still from 26 to 30 per cent. of water, showed in the end that they contained from 8 to 9 per cent. of water. The very careful wetting of the brickwork in the case of good Portland cement is, according to Michaelis, therefore only necessary if the setting is influenced by a high climatic temperature. Practically, however, this suggestion is very unadvisable.

7. Michaelis asserts, on the basis of many experiments, and in positive contradiction to the experience of others (Feichtinger and Heldt), that already hardened Portland cement, by a renewed burning (assuming that by mixing with a surplus of water no substantial loss of constituents has taken place, and that the right and a sufficiently high temperature for the burning has been applied), produces a powder just as dense, scaly, crystalline, and of equal capability for getting hard, as at first. Feichtinger would be therefore wrong in deriving his theory of the combination between the acid silicates and the free lime surrounded by them only taking place through the influence of the water, from the fact that already hardened and reburnt cement absorbs water immediately and without getting hard. He had probably only applied a temperature too low.

8. Michaelis disputes, therefore, with Winkler not only the existence of free lime in the burnt cements, because he considers such uncombined state at the heat employed for burning as unlikely; but because Portland cement with water does not, according to him, become warm in setting, which were there free lime in it must be the case. He has taken from the same kiln, and at the same time, different samples, and has found that the normal and thoroughly burnt pieces, even reduced to the finest powder, do not so get warm, while less well aggregated pieces, the particles of which may be coagulated in the burning, but which had been exposed to less heat, harden quickly, indeed, but also get warm, and that the more, the finer they are powdered; so that he concludes certainly that a cement which does not become warm cannot contain any free lime.

9. There are therefore formed during the burning, aluminate of lime (oxide of iron—lime, *i.e.*, in which $Fe_2 O_3$ plays the part of alumina) and

silicate of lime, which are, after the cooling of the cement, in a certain chemical state of tension, which cannot longer exist upon contact with water, as its relation to all, especially to the lime, produces the formation of very constant and stable silicic combinations :—

(*a*) Either there exists in the cement the acid silicate $Ca\,O, Si\,O_2$, along with, in smaller amount, the basic aluminate $5\,Ca\,O, R_2\,O_3$ (to $10\,Ca\,O, R_2\,O_3$), and then, as the latter is dissolved by the water, the separated lime connects itself with the silicate (probably to $5\,Ca\,O, 3\,Si\,O_2, 5\,H\,O$) and only afterwards lime remains free, which later, as silicate and aluminate, connects itself with water; whence Feichtinger has been induced to the supposition of the involved (*umhülten*) lime, before referred to.

(*b*) Or there is produced in the fire the basic silicate ($3\,Ca\,O, Si\,O_2$) besides the less basic aluminate ($3\,Ca\,O, Al_2\,O_3$), and then the former one will be first dissolved; there is then formed again ($5\,Ca\,O, 3\,Si\,O_2\,5\,H\,O$) and besides free hydrate of lime $Ca\,O, H\,O$, which, notwithstanding its being dissolved by the surrounding water, may very easily be separated from that again by the withdrawal, through the progressing hydrate formation, of the water from the solution.

Any existing silicates of alkalies dissolve with the lime hydrate, hardening to silicate of lime; or if they meet also with carbonic acid, become decomposed, separating silicic acid, and being cemented by it. Besides this, the lime hydrate is in respect to the carbonic acid of great importance to the induration of the cement.

With the above-mentioned stöchiometric limits the quantity of water in the hardened cement agrees so far, that with the 60 per cent. of lime contained in the burnt cement correspond about 19 parts of water (or 1 equivalent, $Ca\,O$ to $1\,H\,O$), or 16 per cent. of the hardened compound, so that the latter principally contains the following combinations :

(1) $5\,Ca\,O, 3\,Si\,O_2, 5\,H\,O$,
(2) $3\,Ca\,O, Al_2\,O_3\,(Fe_2\,O_3)\,3\,H\,O$,
(3) $Ca\,O, H\,O$;

or, if we assume a theoretical cement, neglecting the magnesia and alkalies, composed of—

45 equ.	$Ca\,O$,	65·6
15 "	$Si\,O_2$,	24·2
3 "	$Al_2\,O_3\,(Fe_2\,O_3)$,	10 2
		100 0

the following expression is obtained :—

$$3\,[5\,(Ca\,O, Si\,O_2) + 10\,(Ca\,O, Al_2\,O_3)] + 45\,H\,O = 3\,(3\,Ca\,O, Al_2. O_3, 3\,H\,O) + 5\,(5\,Ca\,O, 3\,Si\,O_2, 5\,H\,O) + 11\,(Ca\,O, H\,O).$$

(*To be continued.*)

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXXII.

MALLEABLE CASTING.

It remains for us to complete this branch of our subject by some consideration of the physical and chemical conditions of malleable cast iron, and of what probably takes place in the annealing furnace, by which the change in the molecular constitution upon which the malleability depends, is caused; in a word, to state our views as to the *probable theory of the process*, so far as that is possible in the present state of ignorance in which it has been left by experimental metallurgy.

It is curious enough, though a little humiliating, to wade through volume after volume of systematic chemical authors, and find how one has repeated the statement of the other preceding in boldly setting down the malleable cast-iron annealing process as one of *decarburization.* Reaumnr, whatever he may have speculated about the nature of the process, was very philosophical and very modest in the title which he gave it. He does not call it a process for the *decarburization* of cast iron, but simply one *pour adoucir*, for *softening* cast iron, so that it became more or less malleable. How, indeed, should he have gone further when his own thoughts were so little clear, that he tried all sorts and conditions of imbedding or cementing (as it is called) materials, even those of the most opposite properties; and when he found that a great number of most heterogeneous bodies, when thus employed, seemed all to give pretty much the same results. Reaumur, however, really does appear to have speculated upon the process being possibly one of the nature of decarburization.

Who was the first courageously to convert speculation into hardy assertion, by affirming that the malleable cast-iron process was one of decarburization through the reaction of the oxygen of the imbedding hæmatite, we do not know; but apparently, from the date of Lucas' patent, 1804, downwards, if not before, one chemical author has just followed another in affirming that it is so, but without presenting anything worthy the name of a proof for the assertion repeated thus from pen to pen. An amusing instance of how fragments of scientific *credos* such as these get sanctified by time and digestion in successive authors' maws, has recently occurred in the *Times.*

In a letter on the subject of early inventors, &c., in steam-marine propulsion, by the well-known author of the canoe voyage of the *Rob Roy* (Mr. John M'Gregor), it was stated that Papin, in 1707, was the first who produced a steam-boat. Some gentleman, who no doubt felt himself a competent "practical man," soon took *Rob Roy* to task—little knowing, no doubt, that upon this particular subject Mr. M'Gregor is, perhaps, the very best existing authority—and told him very plainly he had better write upon something he knew a little about, and not on the history of steam navigation; for as to his ridiculous story about that objectionable Frenchman, Papin, does not Mr. Fincham, a good sound Englishman, state, in his "History of Shipbuilding," that a Spaniard, Blasco de Geray, invented a steam-boat in 1543? To this "Rob Roy" very quietly, but most effectively replies, that he had not quite so overlooked Blasco as his objector assumes. In fact, he had done what Mr. Fincham and a host of other authors, one copying from another, had *not* done. Mr. M'Gregor had gone specially to Simancas, in Spain, and examined the *original* documents of the said Blasco de Geray, and found what? "that there was not one syllable about anything that could be construed into a steam-boat even once alluded to in them." In a word, all the glorious army of authors, with Mr. Fincham following at the tail of the procession, had copied from a Spanish author, who, whether *he* ever had seen Blasco's MSS. or not, gave an utterly falsified account of them; and so, without further inquiry or doubt, this original and first inventor of a baseless fable for the reputation of his countryman, became the first of a line of false prophets in other tongues as well as in Spanish, and finally, of their valiant but unhappily ignorant defender in the *Times.* Well might Raleigh, when he attempted to grapple with a fact occurring under his own window, despair of being able to write his "History of the World."

But ludicrous as is this example of careless cogging and the application of the pickled rod at last, it is far more excusable than our case here, of the slow growth of a creed, and at last the undoubted enunciation of it, in the form that the conversion of cast into malleable cast iron *is* due to decarburization, as a fact that may be taken for ascertained, and question of which need not be thought of. "*La decarburation est obtenue,*" say Pelouse and Fremy, A.D. 1864. "*Les fours de decarburation,*" says M. Brüll, boldly (p. 4.), and we might quote from a score more, in the same sort. "We have already" (referring apparently to p. 110), says Dr. Percy, "considered the process of rendering cast iron to a certain extent malleable by cementing it in hæmatite, and the chemical changes which are thereby induced" (p. 804). Turning back, we find "Carbon may be extracted from as well as introduced into solid iron by a process of cementation which has long been practised. Thus, when cast iron is imbedded in powder of red hæmatite, and kept at a bright red heat during two or three days, *it loses carbon*, ... and is converted into malleable cast iron." It is but to do Dr. Percy justice, however, to add that he produces in support of his dictum two analyses, published by Dr. W. A. Miller, a very reliable authority ("Elements of Chemistry," part 2), "of the metal before and after the process," which do *appear* distinctly to support the statement; the carbon per cent. in these analyses being given thus—

		Before Cementation.	After Cementation.
Carbon—	Combined,	2·217	0·434
	Uncombined,	0·583	0·446
	Total,	2·800	0·880
	Specific gravity,	7·684	7·718

the silicon being reduced also to less than one-half, which Dr. Percy declares "he cannot in the least understand."

Now, independent of the unsolved facts, which still belong to the chemistry generally of cementation, when resulting in the production of steel, and the apparently irresoluble relations that many of these facts present to those assumed to go on in the converse cementation to decarburize iron—some of which Dr. Percy has given—even from his own experiments (p. 110 *et seq.*), there surely is enough on the face of this solitary analysis to show that it is no safe or sufficient guide to base the authoritative enunciation of a made-out theory upon. The specific gravity, for example, is said to be greater after than before cementation. Few are ignorant of the fact that *white* cast iron, which is the state in which, as we have seen, malleable castings exist prior to annealing, is *the very densest* form in which cast iron is known to occur.

Not only then do these results make the cemented metal denser than before, *i.e.*, denser than the densest possible, but they are in so far in conflict with all other observations. Brüll says, "*La fonte malleable est très-poreuse, comme son mode de fabrication devait le faire supposer*," and then he gives as the proof that "oil placed in a pot of malleable cast iron in a few days sweats through it." That it is porous, much more so than the white annealed metal, is, on the fresh fracture, even visible with a lens, though we may just hint a doubt as to this oily fact being much better based than that of the decarburization. Brüll gives, from his own trials, the specific gravities of three specimens of malleable cast iron at 7·10, 7·25, and 7·35 respectively; unfortunately he does not give those of the corresponding unannealed irons. Pelouse and Fremy say, *Elle* (the malleable cast iron) *a peu près la même densité que la fonte*, *i.e.*, the cast iron from which it was produced, and the malleable castings, have the same density before and after annealing, nearly. Entertaining, as we do, the very highest respect for every analysis or research vouched by Dr. Miller's reputation, we should be slow to question the exactness of the two analyses above given, and we do not question them. In a recent conversation, however, which the writer had with Dr. Miller, he was informed by him that he was not certain he had ever analyzed two portions of identically the same cast iron in its white and brittle, and in its annealed and malleable state; we gathered that specimens in both states, which he had examined, wanted this identification, as of his own knowledge; and, without going further, this appears to us to be probably the solution of the difficulties which the discussion of these analyses presents. We must for the present dismiss them as evidence, and, in doing so, dismiss, as far as our knowledge goes, any tittle of evidence that exists so far, for the often repeated statement that the softening of white cast iron in the annealing into malleable cast iron, is due to decarburization at all.

We do not mean, on the other hand, to affirm that it may not hereafter be proved to be so, or that it may not, by adequate research hereafter, be possibly proved that more or less carbon is really, in all or in certain cases, abstracted from the white annealed cast iron by and in the process of annealing, or of so-called cementation. We do affirm, however, that so far there is no evidence whatsoever that this is the fact, and further, we venture to express our own present hypothesis or conjecture from all the facts known to us, that nothing of the sort does take place, and that the total amount of carbon contained in the castings before and after annealing is almost, if not absolutely, the same.

To what then, it may be asked, is the change from white, brittle, crystalline cast iron to soft, fine, gray, granular and tough malleable castings due? That it is *not* due to mere chemical change of constitution, and that change the withdrawal of carbon by the action of the nascent oxygen supposed to be evolved from the heated surrounding powder of hæmatite or anhydrous peroxide of iron, as asserted by writers to whom we have alluded, we conclude from the following facts and reasonings. Reaumur ascertained that a vast variety of very different materials, even of chemical qualities the most opposite, all produced the malleable cast iron; the differences were mainly found in the *time* of annealing; some of the worst, if given time enough, produced the same effects as some of the best. Chalk, which actually evolves carbon in the state of carbonic acid, does as well (the condition of time excepted) as hæmatite, which evolves oxygen. To our own knowledge clean wrought-iron filings, mixed with a little unslacked lime or magnesia powder to prevent their adhering to each other or to the castings, answer just as well as hæmatite, and the following, as a fact, is equally within our own cognizance.

About fifteen years ago the writer visited the workshop of a poor man, whose trade was confined to casting malleable cast-iron three-pronged table forks and table-knife blades. The man had a wretched little shop close to Birmingham, and was assisted in his personal labours by his own family, consisting both of sons and daughters. He made excellently tough and malleable cast iron in the above two forms only, and he annealed his forks and knife blades in nothing more or other than the dry dusty *sand* from the floor of his shop. We saw it filled into the cases, and we saw those from which it was being withdrawn, and observed that his cementing material was little more than clayey dust in small proportion, mixed with a great amount of sand, silex, yellow or reddish from a minute proportion of chemically combined iron probably, and mixed with the whole, though in very small proportion to the whole and very irregularly, was some charcoal or coal dust, and many "sparkles" or little specks of cast iron flown off in "pouring," and of course in so far consisting in part of iron oxides. The man (whose name and address have with lapse of time wholly escaped us) was perfectly aware of hæmatite being commonly used; but he said he had long found by trial that it was useless, or at least, that by giving a little longer time to the annealing his own rough and inexpensive method answered all he required.

Now, though further experiments are still desirable, we may conclude, without much danger of being wrong, from what precedes, that any porous powder whatsoever, in which we can imbed the castings, and which shall be of such a nature as to keep them sufficiently included to be tolerably free from oxidation in the annealing furnace, will answer the purpose; and that those powders which are densest and the best conductors of heat will answer best, and admit of the process being soonest concluded, because they admit of the castings being soonest heated throughout to the necessary temperature. Hæmatite happens to possess, when in powder, all these qualities in a high degree, and probably it would be difficult to find the same equally combined in any other pulverulent material equally plentifully to be obtained.

It is certain the hydrogen and carbonic gases of the annealing furnace find their way in amongst the powdered hæmatite; but if nascent hydrocarbons and carbonic oxide or acid come in contact with the white cast iron at a bright red heat, how is it that the oxygen of the hæmatite does not go to these, and not to the solid carbon already combined in the cast iron? and how is it that contact with nascent carbon, or carbon and oxygen, produce upon the red-hot iron, under in many respects very like conditions, the opposite effects, of causing carbon to combine with the metal in steel cementation, and abstracting it in malleable iron cementation?

But if the change effected by the annealing be not a chemical one, or mainly not so, how is it to be explained? Our hypothesis is, that the conversion from brittle white into malleable cast iron is attributable mainly, if not altogether, to a molecular change in the substance; one *due to the continued heat*, with air nearly excluded, to which the iron is exposed, favouring the intermobility of its particles, and that the molecular changes which occur mainly affect the carbon which the white cast iron contains. This we shall endeavour to make more intelligible in our next paper.—Ed.

NOTICES OF RECENT IMPROVEMENTS IN IRON AND IRON-MAKING.

Professor Tunner states in a Report upon improvements made in the production of pig iron "as evidenced at the late Exhibition at Paris of 1867," that he could not find in the Exhibition much technical progress. The enlargement of the blast furnaces in their height and diameter appears to be still the object of trials on a large scale in England. A furnace above 80 feet high has been erected in the last year in the Cleveland district in England (Messrs. Morrison's, we believe), and the results obtained, as regards the consumption of fuel, have been much praised; but such hard coke and such coarse aggregates of ironstones as are worked in that district are not to be found again soon, nor everywhere. These results can, therefore, perhaps only be considered as very important locally. The diameter of the furnaces at the bottom appears to have reached in round furnace cavities to 7 feet diameter as its present limit, although that again widens itself during the working of the furnace, and yet is found still safe and right for use up to 8 or 9 feet diameter. A diameter of 6 feet at the bottom is the general measure for the larger furnaces, and especially for those which are used for the lower numbers of pig iron. An acknowledged progress has been made, and is still becoming extended in application, in the heating of the blast to the highest possible degree. Even the coke-consuming furnaces, which are supplied with a cast-iron blast-heating apparatus, blow with air heated to 300° or 360° C.; but the blast-heating apparatus constructed upon the principle of Siemens' regenerator, of which there is also one in use at Friedrich Wilhelmshütte, near Siegburg in Westphalia, affords a still higher temperature, and would be more generally employed if their maintenance had not been found so far subject to so many interruptions and repairs, arising mainly from the interior lodgments of dust upon the brick heaters. With the high temperature of the blast is not only connected an enlargement of the furnace at the bottom, but at the same time a narrowing of the furnace mouth, and also with the complete disappearance of the boshes, whence has been attained the further advantage of a regular descent of the charge in work. The English and Scotch furnaces distinguish themselves in that way before all other ones. Models of blast furnaces were exhibited in the French, Prussian, and Swedish departments. In the former ones was more particularly shown the methods adopted in France for catching and utilizing the gases. The methods used for the charging were also shown, without, however, according to Tunner, representing any innovation worth imitation. One rather complex, but ingenious and probably effective method, for constructing the furnace top so that the charge should be fed in with perfect uniformity all round, and that at no moment should any feeding aperture permit the escape of gases, exhibited by France, does appear to us to merit somewhat warmer praise. The furnace model of the brothers Büttgenbach, in Neuss (Rhenish Prussia), Tunner deems the most instructive one; very original is the distribution of the gas, which appears to be effected through five hollow cast-iron columns, which carry also the broad circular crown beam upon which the brickwork above the furnace mouth rests, and which is only strengthened by iron hooping instead of by a mantle of boiler plate. The furnaces built during these last years on the Continent are generally constructed after a Scottish pattern, that of the so-called boiler-plate mantle furnace (*Blechmantelofen*), or "cupola," as frequently called by us; but as regards the cost, Tunner considers there is nothing saved by that. In the country of Siegen (Westphalia), where most of the new furnaces are also constructed thus, as many are also in Cleveland (Yorkshire) and in Cumberland, for a rather large furnace, the plate mantle, with the ironwork at the furnace mouth, requires about 400 centners of plates (20 tons, nearly, English), the price of which, including the fitting up, will be about 6½ thalers (19*s.*) per centner. The cast-iron cill plates upon which the mantle rests, and the supporting columns, weigh between 700 and 800 centners, costing 3 thalers (= 9*s.*) per centner. The outlay for one of these mantles will be, therefore (without the brickwork for the foundation), nearly 8000 florins (£800), a price for which almost in all localities a brick-built mantle could be obtained. A plate-iron mantle or cupola furnace is, perhaps, under certain circumstances more desirable, but it is questionable whether it is free from influence in producing loss of heat by radiation and evection. If a furnace, therefore, is to be erected for permanence, and if, especially, the price for the fuel to be employed is very high, a brick-built shaft is, in Professor Tunner's opinion, to be preferred before the plate mantle or cupola furnace.

Raschette's furnaces, which appeared before the public some years ago at the London Exhibition of 1862, have only been exhibited in the Russian and Prussian departments. The model in the latter one from the Hartz forest was destined only for lead-smelting. It appears, therefore, that Raschette's furnaces for the production of pig iron have not been adopted in practice except in Russia, for which the principal reason may be their alleged failure on trial at Aubel's works near Muhlhausen. Tunner, however, has been assured by a Russian engineer, that these furnaces give in Russia good results when worked for the production of white or mottled pig irons, though not for producing gray pig iron. Assuming the correctness of this statement, Tunner finds a reason for it, mainly, in the small height of the furnace. It is right to add, however, that the editor of the *Berg-geist* states, that in Russia a series of furnaces after Raschette's system (he enumerates ten of them) are at present worked with perfect success, not only for gray, but also for white and mottled pig irons. The above-mentioned trial by Aubel, he states, had not taken place at Muhlhausen; but a furnace arrangement which had been executed in all its parts at Muhlheim, near Cologne on the Rhine, and upon the design of the Raschette furnace, was erected there and had not failed as a furnace, for a great number of engineers, amongst whom have been some of the first furnace-men of our time, had approved its working as good, and had remarked the most satisfactory products of metal from it; but certainly the limited liability *company* who owned the furnace had failed after the time that their engineer Aubel, who was the representative of General Raschette and who built the whole of the works, had been removed from the management. Aubel's trials at Muhlheim, therefore, cannot be considered at all in any technical relation, nor as proving anything disadvantageous to the Raschette furnace, as to which we may add that very little is so far accurately known in this country.

The following recent statistics as to iron-making in France are not devoid of interest, as showing the shifts to which iron-masters there are driven by scarcity and dearness of fuel, and yet how ably and well they meet this deficiency:—

The total production of charcoal-made pig iron for 1867, in France, is estimated at 177,300 tons; of pig made with two combustibles, 78,700 tons; and of pig made with mineral combustible, 886,800 tons; showing a total of about 1,142,800 tons, of the value of £4,805,800. In 1866 the production of charcoal-made pig attained a total of 213,000 tons, while that of pig made with two descriptions of combustible was 89,900 tons, and that of coke-made pig 950,200 tons; showing a total of 1,253,100 tons. The decline in the production of pig in France this year is thus estimated at 110,300 tons. The French production of charcoal-made iron this year is estimated at 41,700 tons; of iron made with two combustibles, 23,400 tons; and of coke-made iron, 735,900 tons; showing a total of 801,000 tons, of the value of £7,393,880. If we compare these results with those for 1866, we find a diminution of 8700 tons in the quantity of charcoal-made iron, a diminution of 4700 tons in the quantity of iron made with two combustibles, and an increase of 2500 tons in that of coke-made iron.

The result goes to show, on the whole, an increase in the supply of good coal fuel and coke, and to support the long-known increased and still increasing scarcity of charcoal. This view is further supported, perhaps, by the falling off for the last three years in the importation of English coal into France. The general diminution in the make of French iron is to be accounted for by fiscal causes, in which we in England have still more severely participated.—Ed.

ANCIENT COINS AND METHOD OF COINING.

(*Continued from page 136.*)

By Joseph Newton, Royal Mint.

It is generally acknowledged that the very first allusion to Britain on Roman coins occurs in the instances which exist of those of Claudius. One of these was struck in commemoration of the triumphal arch decreed to him by the senate after his conquest of Britain. This was minted, as it is supposed, three years after that event, namely, A.D. 46. It has for an obverse the head of the emperor in profile, and laureated. The inscription (abbreviated) is as follows:—Ti. Claud. Cæsar Aug. P. M. Tr. P. VIIII. Imp. XVI.—intended to read, Tiberius Claudius Cæsar Augustus, Pontifex Maximus, Tribunitia Potestate nonum, Imperator decimum sextum," which may be translated, "Tiberius Claudius Cæsar Augustus, holding the office of High Pontiff, possessing the Tribunitian Power for the ninth time, and Imperator for the sixteenth time." The reverse of the coin represents a triumphal arch surmounted by an equestrian statue between trophies, and bears the inscription De. Britanni, no doubt in direct reference to the then recent British victories. Another remarkable coin is that struck in honour of Britannicus, the son of Claudius, the inscription on which is in Greek. From this period to the reign of Hadrian no allusions to Britain occur on any of the coins of its Roman governors. The most remarkable specimen of Hadrian's coins is that struck to commemorate his arrival in Britain. It has for its obverse the bust of the emperor, with the inscription, Hadrianvs Avg. Cos. II. P.P., as an abbreviation of Hadrianvs Avgvstvs, Consvl Itervm, Pater Patriæ, which may be translated "Hadrianus Augustus, Consul for the second time, Father of the People." On the reverse is depicted a propitiatory sacrifice, with the inscription, Adventvi. Avg. Britanniæ ("for the arrival of Augustus in Britain"), and underneath S.C., for Senatvs Consvlto ("by decree of the Senate").

It was during the tenure of imperial power by Hadrian that the figure which has formed the model for the Britannia on our modern copper and bronze coinages was first introduced. The obverse of this coin has the head of the emperor laureated and accompanied by the titles in the usual form; but the reverse represents a female figure seated on a rock and holding a spear. Mr. Humphreys observes, in reference to the particular coin in question, that "some consider the figure shown on the reverse to be a personification of Britain—in short, a Britannia; while others suppose it to be Rome, though without the usual attributes symbolizing the act of taking full possession of the country." But the figure, evidently allegorical in character, would seem rather as armed and in a condition of repose, to imply peace, after a successful campaign such as that undertaken at the same period against the Caledonians. In this case the inscription "Britannia" must be held to refer to the scene of action rather than to the emblematical figure. No doubt, however, it was for a long period considered to mean a figure of Britannia, and in the semi-classical taste which, with others of a less innocent kind, prevailed in the time of Charles II., it undoubtedly served as a model for the ornamentation of the first copper coinage of England. The beautiful Frances Stuart formed the actual model for the details of the die which Rawlins engraved, and the leg was undraped in the design then adopted for the subsidiary coinage.

It is scarcely essential, in the few chapters which it is intended to devote to "ancient coins and methods of coining," that every remarkable coin of the Romish period should be indicated. In fact, the task in so limited a space would become an impossibility; but it is very desirable before advancing to the second division of our subject, that one other Roman emperor should be named—Diocletian. This monarch was undoubtedly a great social reformer in his way, and among other changes inaugurated by him was the establishment of mints in many of the tributary provinces of the Roman empire. Prior to this epoch the mints of Rome had supplied coin for all the western portion of the vast dominions which had been subjugated by its gigantic power. It is on record, indeed, that during the reign of Aurelius no less than 20,000 coiners were employed in the imperial coining establishments of the "Mistress of the world." The new mints which were organized at the instigation of Diocletian were established as far north as Treves, and from this place a very large number of coins was subsequently issued. This money bears distinguishing marks, which demonstrate the place of its nativity. Several similar manufactures of hard cash were planted in Gaul, beside the principal one, which was at Lugdunum (Lyons), and it is pretty certain that at least one was founded simultaneously with those of Gaul in Britain. In fact, coins are in existence now of the time of Diocletian, on which are the letters P. Lon., abbreviations for "Pecunia Londinensis," or M. L., for "Moneta Londinensis."

The undoubtedly British coins of the usurper Carausius, who in the reign of Maximianus seized the sovereignty of this island, are interesting, as illustrative of the history of our native land. This extraordinary man not only took possession of Britain, but successfully withstood the attempts of the Romans to regain it for the space of six years; that is, from A.D. 287 to 293, in which latter year he was assassinated by his minister, Allectus, who governed Britain for three years more in defiance of Rome. Mr. Akerman, in his invaluable and voluminous work on Roman coins, has given engravings of a great variety of coins struck by Carausius. Among these may be cited one in particular having the bust of the usurper, with the paludamentum and the abbreviated inscription, "IMPERATOR CARAUSIUS PIUS FELIX AUGUSTUS" for its obverse. On the reverse, the emperor, bareheaded, joins hands with a female, who also holds a trident; the female figure is unquestionably intended to mean the genius of Britain, and the trident is emblematical of ruling the waves. In the British Museum a magnificent gold coin of Carausius is preserved, and its obverse consists of an admirably engraved figure of Jupiter. It is believed to have been struck in the Mint of London, for beneath the figure are the letters M. L., for "Moneta Londinensis," as previously explained.

Those who may wish to learn more of the Roman coinage circulating in Britain during its occupation are referred to the work of Akerman. As to the methods of coining practised by the conquerors of this island many opinions have been advanced; but it is pretty generally admitted that the hammer, or some equivalent means, was, next to the die, the most important implement in use. This theory is supported to a considerable extent by the number of Roman coins still extant which are incuse or indented on one side. This circumstance arose from the carelessness of the manipulators engaged in their manufacture; they evidently sometimes neglected to withdraw the coin after it had been struck, so that the next disc of metal placed to receive the blow received not only the impression of the die above, but took another, in intaglio, from the finished coin beneath. Such casualties occur, indeed, occasionally even now at the Royal Mint of England through the defective action of the stamping machines, for no mechanical contrivances can be made infallible. At the Mint such incuse coins are relegated under the name of "brockages" to the melting pots. The Romans were less careful evidently, for the witnesses to their neglect are abundant.

Many Roman coins are to be met with which bear two imperfect rows of letters in the legend instead of one perfect row. Technically this is known to coiners as "doubling" a coin. In former days it arose from the vacillation of the piece under the hammer; now, it not unfrequently happens from the coin accidentally getting two blows from the press instead of one only. In either case the phenomenon testifies to the fact that the piece which exhibits it was struck, and not cast.

The irregularity of form among Roman coins is another proof that they derived their impressions from the force of blows unevenly administered, and when they were not placed fairly to receive the impact. Most of them are, indeed, "out of the round," as a modern minter would say. If further evidence in this direction were needed it might be obtained in the shape of the dies themselves, many of which are in existence—indisputably and veritably Roman dies—and to be found in the Imperial Mint of France. Some of the dies are composed of mixed metals, equal parts of copper, tin, lead, and zinc, while others are of steel.

It is true that there are vast numbers of coins bearing the head of Septimus Severus which were palpably cast in moulds. They are considered to have been the work of forgers, however, and to have been produced on the same nefarious system that is now in practice for imitating the florins and shillings of Queen Victoria.

NEW GLAZE FOR POTTERY.

A GLAZE without lead for ceramic products has been produced by M. Richard, manufacturer of pottery at Saint Christophe, near Milan (Italy). M. Salvetat, chemical director at Sevres imperial china manufactory, in a report made in the name of the committee for chemistry to the *Société d'Encouragement* of France, after having pointed out the dangers which may arise from glazes containing lead, especially in the coarse pottery destined for the use of the poorer classes, states that M. J. Richard, a manufacturer of French descent, and proprietor of one of the most flourishing establishments of Italy, has obtained admirable results by means of a glaze, to the composition of which he wishes in the public interest to give the widest publicity. The following is the composition of this glaze :—

	Kilogrammes.
Carbonate of soda,	1000
Boracic acid of Tuscany,	800
Kaolin,	725
Carbonate of lime,	250
Sulphate of lime,	250
Crystallized felspar,	750
Quartz of Tessin,	280
Fluate of lime,	150

In mixing these substances together sufficient oxide of manganese of Piedmont must be added, to produce such tint as may be required. Afterwards the fritt is well and finely ground, and for every 460 parts of the fritt 110 parts of kaolin and 52 parts of felspar are then added. The glaze is then laid on in the ordinary manner by dipping; but as the density of the mixture is different from that of lead glazes, a larger number of pieces can be glazed with the same weight of materials. This glaze, M. Salvetat states, when applied, either upon the glazed cups of M. Richard, or upon pieces which he had glazed with material reproduced according to the formula of that gentleman, proves by experience sufficiently hard, does not become cracked, and is perfectly inoffensive in use, qualities which the consumer ought to value highly. The feelings of liberality with which the author has divulged his composition augment the merit which the *Société d'Encouragement* recognizes in its correspondence, on the part of M. Richard. A great deal, and some by no means cheap pottery, in so-called stone china or other wares for dinner services, &c., is even yet made in England, the glaze upon which, though transparent, nearly colourless, thin, fluid, and otherwise good, yet possesses apparently a coefficient of contraction so different from that of the "biscuit," or body of the ware, that after a shorter or longer time the whole surface cracks all over through the whole depth of the glaze, in trellis or net-work, like that of the well-known Indian or Chinese "crackle china," a product made purposely, and most probably, by taking advantage of that very property, though we believe the method is held to be a secret.

The writer possesses a dinner service by an excellent British maker, which, quite without blemish at first, within five years got thus crackled all over; and as gravy, or other greasy and dark coloured fluids got into these cracks when in use, the service soon became unserviceable. The *not* doing this is one prime condition of any glaze, and only second to its being insoluble in the fluids used in cookery, &c., and free of poisonous materials.

MINING SAFETY CAGES.

We readily give the increased publicity of the *Practical Mechanic's Journal* to the following circular which has been issued by the North of England Institute of Mining Engineers, with a view to collecting all available information upon the highly important subject of safety cages. Numerous as are the contrivances that so far go under this name, the assertion may be hazarded, that it is more than doubtful whether at this moment such a thing as a real *safety* cage exists. No better method for approaching improvement can be adopted than this, which Bacon so well called "taking stock of our knowledge."

The committee appointed by the North of England Institute of Mining Engineers to inquire into the utility of safety cages and disconnecting hooks are desirous of having any information of the practical application of any invention of this nature you can give, and beg respectfully to ask you to fill up and return the annexed form at your earliest convenience.

I am, Sir, yours faithfully,

THEO. WOOD BUNNING.

QUERIES.

1. Have you any safety apparatus connected to cages?
2. Have you any disconnecting hooks to pit ropes?
3. If so, state whose invention.
4. State the name of the collieries and pits to which it is attached.
5. Briefly state the mode of action.
6. The weight lifted.
7. Description and size of guides.
8. Ordinary speed at which the cage travels.
9. Depth of shaft.
10. Have you had any accident which practically tested the usefulness of the safety apparatus or hooks employed?
11. Have you had any instance of the lives of workmen being preserved, or property protected from injury, by the application of such safety apparatus?
12. Have you had any case where the safety-cage apparatus or hook got out of order and caused an accident?
13. How long have you used the safety apparatus or hook?
14. Do you still use them?
15. Is it expensive to keep them in good working order?
16. In case of disconnecting hooks and overwinding, have you any machinery acted upon by the cage being raised above its ordinary position to shut off the steam from, reverse, or stop the engine, or to check the speed by the application of a steam or other brake?
17. If you use disconnecting hooks, or any other appliances to sever the connection between the cage and the rope, in case of overwinding, have you any provision to retain the cage in any elevated position to which it may be raised, and prevent its falling down, such as keps, movable platforms, tapered slides, timber, &c.?

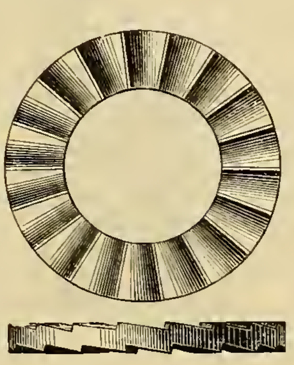
Newcastle-upon-Tyne.
July 31, 1868.

CHAPMAN'S PATENT RATCHET WASHERS.

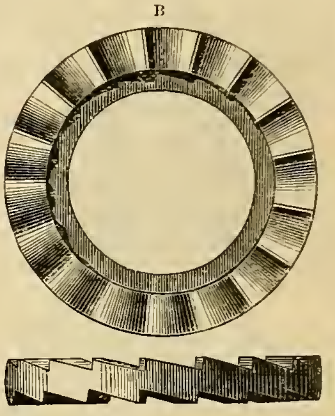
From the above woodcuts the idea will be at once recognized and understood upon which C. W. R. Chapman, C.E., of Westminster, has based his extremely simple and not less ingenious invention of a form of washer for screw pins or the nuts of screw bolts, which, when placed beneath the head of the screw pin or the nut, and either of these screwed up tight, shall prevent the unscrewing again of the pin or the nut by any shaking or any other action short of that of a regular lever spanner.

Each washer, it will be seen, is an annular disc of steel, the opposite faces being formed into radical ratchets with sharp-edged teeth, and reverse (as ratchets) to each other; the direction of both being for right-hand screws or nuts, the reverse of those for left-hand ones. While the screw pin or nut is being tightened up the ratchet washer slides, "backing" easily over the inclined faces of its teeth; but attempt to slack back, and the ratchet teeth at once dig into *both* faces of the thing screwed into by the pin, and of the latter, or of the thing bolted through, and of the nut, and rotation can only take place by cutting away a thin circular shaving from both such opposing faces. The ratchet washer in the act of unscrewing, in fact, becomes a flat "rose tool," acting more or less, simultaneously upon both faces opposed to it, for the brief interval that elapses before the enforced slacking of the pin or nut frees both from contact with the washer. These washers are punched and stamped out of sheet steel, and are tempered *hard*. Two forms have so far been produced, as in the figs. above, viz., one, A, with the whole face of the washer ratcheted; the other, B, with an interior and concentric, flat bearing ring surface for the thing bolted or pinned, or for the nut, or for both at pleasure.

A



B

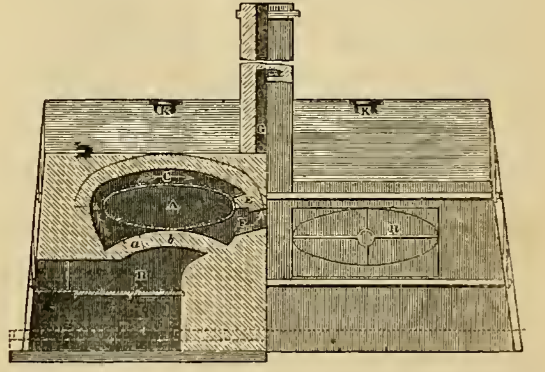


We are not informed at what price these washers can be brought to market. It ought not to be a high one, with proper machinery for their production. Should the price not prove too high, and that they shall prove themselves in actual and prolonged trial as effective as we anticipate they will, these washers will unquestionably be a highly important element of construction in the fishplates of permanent way, in iron-bridge work, and generally in every case in which screw pins, bolts, or nuts are found liable to shake loose by vibration. The specification of this patent has, we believe, not yet been printed, nor the washers as yet brought into commerce.—Ed.

MR. AITKEN'S METHOD OF TREATING IRONSTONES.

In a former part of this journal, present volume, page 48, we briefly mentioned that considerable economy in the consumption of fuel for reducing iron ores is stated to have been recently effected at the Almond Ironworks, near Falkirk, by Mr. Aitken; that economy being directly due to what is called the *coking* or *carbonizing* of the ores in place of *calcining* them, as hitherto practised, and whereby, as is affirmed, nearly the whole of the carbon contained in the ore, whether chemically or mechanically combined, is retained, to serve as fuel for effecting the reduction. Some months' practice at the Almond Works has now so

Fig. 1.



fully established the value of the process, that we proceed to lay the *modus operandi* more completely before our readers.

Almost any kind of apparatus in which coking operations upon coal are or can be conducted may be used, but arrangements similar to those shown at figs. 11, 12, 13, 14, and 15, are what we understand have been finally adopted, although other forms, such as are shown at fig. 1, have been and are intended to be employed.

Fig. 2.

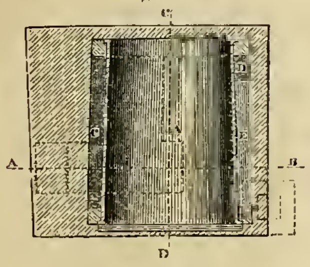


Fig. 3.

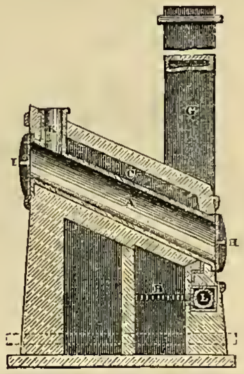
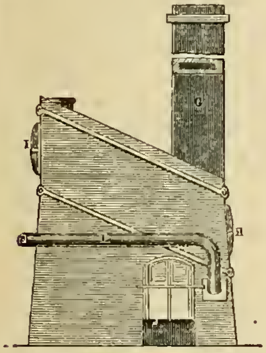


Fig. 1 represents a part end elevation and transverse section of two retorts, the right-hand half being in elevation and the left-hand half a section on the line, A–B, of the sectional plan, fig. 2; fig. 3 is a transverse section through the centre of one of the retorts; and fig. 4 a left-hand end elevation. In these figures similar parts are indicated by corresponding letters of reference.

Fig. 4



A is the retort into which the iron ores or ironstones are placed to be carbonized. The retorts, A, are open at both ends, the lower end being somewhat larger than the upper end, so that the charge may be easily drawn after the iron ores or ironstones have been sufficiently treated; B is the fire grate upon which the fuel is placed, part of the heated gases from which pass through the flue or opening in the roof of the furnace, shown dotted at *a*, and the remainder pass through at the back of the arch, *b*, this arch being placed for the protection and support of the retort, fig. 1. The gases pass to and round the upper side of the retort, A, in the direction indicated by the arrows in the flue, C, fig. 1, thence through the opening, D, fig. 2, in the flue division, E. The gases thence pass along the flue, F, to the front or lower end of the retort, where they issue into the chimney, G. The iron ores or ironstones which are to be treated are filled into the retort, A, at the upper end, the lower door, H, having been previously secured; after the retorts, A, are charged the upper door, I, is secured and the fire in the furnace, B, is lit. During the process of coking or carbonizing the iron ores or ironstones, air is or may be admitted to the retorts, and the volatile matters are or may be drawn off by the branch pipe, K, to suitable condensing vessels, or they may be utilized at once for heating the distillatory apparatus by connecting the branch, K, to the pipe, L, which may be provided with suitable burners. After the ores have been sufficiently treated the branch pipe, K, is closed, and the retort is allowed to cool down, or the charge is drawn and the retorts immediately charged with fresh materials.

Fig. 5.

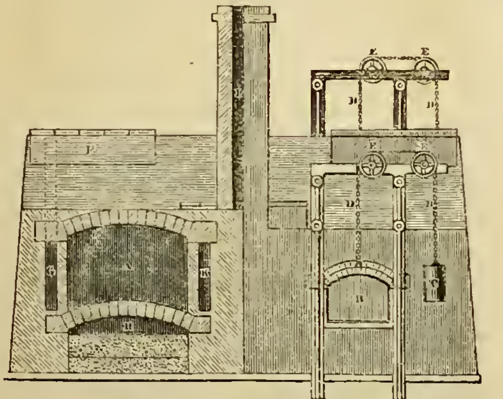


Fig. 6.

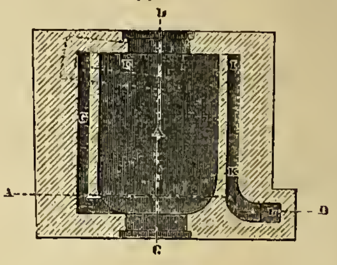


Fig. 5 represents a double or two coking ovens combined, one of the ovens being shown in elevation, and the other is a section on the line, A–B, of the plan, fig. 6; fig. 7 is a transverse section on the line, C D, fig. 6. The iron ores or ironstones are placed in the oven, A, which is furnished at the top and the bottom with sliding doors, B, balanced by means of weights, C, which are connected to the doors, B, by chains, D, passing over the pulleys, E. In this oven no furnace is provided, it being intended to effect the carbonizing of the iron ores or ironstones contained in the oven, and thus utilize the volatile carbonaceous matters contained in the ores. The admission of air is regulated by means of the sliding doors, B, and the heated gases pass from the oven by the passage, F, fig. 7 (and shown dotted at figs. 5 and 6) into the side flue, G, thence to the flue, H, under the oven from which they pass by the opening, I, fig. 6, and escape by the flue, K, to the chimney, L.

Fig. 7

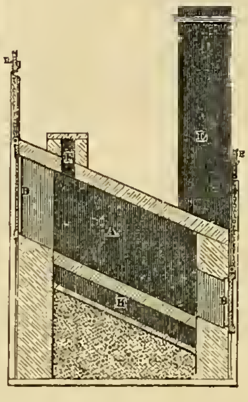


Fig. 8.

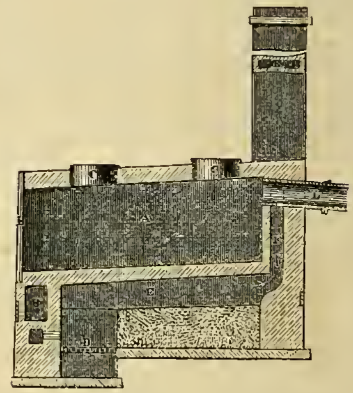


Fig. 8 is a longitudinal section on the line, A B, fig. 10, and fig. 9 a transverse section on the line, C D, of the plan, fig. 10, showing another construction of carbonizing oven.

Fig. 9.

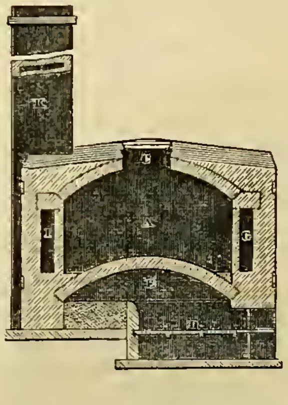
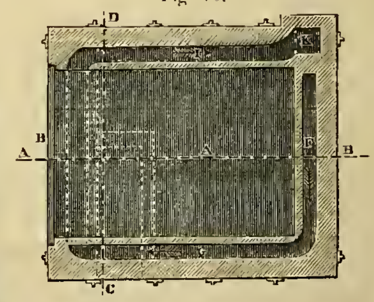


Fig. 10.



A is the oven or chamber in which the iron ores or ironstones are placed to be carbonized. In this case the oven, A, is provided with a door, B, at the lower end by which the charge is withdrawn after being sufficiently treated, and the iron ores or ironstones are supplied by the openings, C, in the roof of the oven. The furnace, D, from which the oven is heated is placed in the lower end of the oven, as shown in fig. 1, and dotted on fig. 10. The gas from the furnace passes along the under side of the oven by the flue, E, thence into the flue, F, figs. 8 and 10, whence it passes round the side flue, G, as indicated by the arrows; the gas thence passes from the flue, G, under the lower end of the oven, A, by the flue, H, fig. 1, into the chimney, K. Fig. 11 is a vertical section, and fig. 12 a sectional plan, of a tower or vertical chamber in which iron ores or ironstones may be carbonized.

The iron ores or ironstones to be treated are placed in the chamber, A, having air holes, B, formed in the side walls to admit air when necessary. A pipe, C, is placed in the bottom of the tower and connected to suitable condensing vessels, so that the volatile matters may be drawn off and preserved for after use. An arch, D, is formed over the pipe, C, to protect it from the falling in of pieces of iron ores or ironstones as they are filled in by the door, E, in the top, F. When the chamber, A, is filled the iron ores or ironstones are kindled at the top; at this time the air doors, B, are closed, and air may be admitted by the door, E, in the top; when the iron ores or ironstones on the top are coked the door, E, is shut, and the upper row of doors in the sides of the tower may be opened to admit air, and so on, shutting the doors as the layers of iron ores or ironstones are coked at that level, and opening the next row until the iron ores or ironstones at the bottom of the tower are coked. During the process of coking the volatile matters are drawn off as they are produced through the holes, *a*, in the arch, D, by the pipe, C, to the condensing vessels. When the coking or carbonizing process is finished, the iron ores or ironstones may be watered out and drawn through the doors, G. Instead of drawing off the volatile matters at the bottom of the tower, the pipe, H, which leads to the condensing vessels may be placed at the top of the tower in communication with a flue, I, formed in the wall of the tower, shown in fig. 11, and the iron ores or ironstones may be kindled at the bottom and coked gradually upwards; the air doors being opened and shut according to the principle hereinbefore described.

Fig. 11.

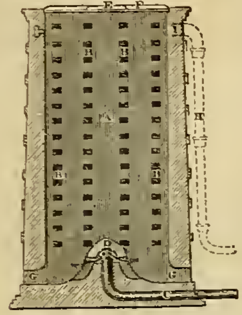
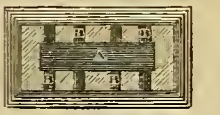


Fig. 12.



The following figures have reference to another apparatus for carbonizing iron ores or ironstones, by placing the ores in one or more layers upon a perforated platform or bed having a movable arched covering.

Fig. 13 is a longitudinal section through the platform and arched cover; fig. 14, a transverse section; and fig. 15 a plan, showing the condensing pipes. A is the platform upon which the iron ores or ironstones are placed, and B, the perforations through which the heat and products of combustion are drawn downwards into the flues, C, through which they pass to the condensing pipes, D, by means of the action of the steam jet issuing through the nozzle, L, these pipes, D, being connected with suitable vessels wherein the condensable matters are collected and preserved for use. E is an iron arched covering, the inside of which may be lined with firebricks or other suitable materials, *e*, as shown in figs. 13 and 14. The arched covering, E, is carried upon wheels or rollers, *a*, fig. 13, and shown dotted on fig. 14, so that when the heap or layers of iron ores or ironstones are built or laid upon the platform, A, it is covered by the arched covering, E, which is run along the rails, *b*, fixed on the side walls, F. By this means any convenient size of heap may be formed, as the arched covering is, by preference, made in sections, and each of which is run along the rails, *b*, and placed close to each other until the heap is covered. The ironstones or iron ores may be fired or ignited on the top, and the cover, E, run over the heap, the heat or gases being drawn down as above and hereinafter set forth. To prevent danger from explosion, or a high pressure of gas which may occur during the carbonizing of the iron ores or ironstones, part of the end, G, which incloses the arched covering, E, is hinged as shown at *c*, fig. 14, so that it may be blown open and the explosive or high-pressure gases may escape before they have collected to a dangerous extent. Holes, *d*, are formed in the arched covering, E, to admit air to the heap after it is fired. To facilitate the condensing and collecting of the condensable matters during the carbonizing of the iron ores or ironstones, water may be caused to flow through the flues, C, and the pipes, D. Steam and water may be also injected amongst the iron ores or ironstones from time to time, while combustion is going on, to facilitate the condensation of the gases, and towards the end of the process steam and water may again be admitted for the purpose of facilitating the separation of the sulphur, and salt or salt water may be admitted to render what sulphur remains harmless. The gases which are not condensed escape by the pipe, H, to a chimney or fire-grate not shown in the drawings, or the exhausting of the gases is maintained by any exhausting or forcing apparatus or means. When the coking or carbonizing process is finished, the arched covering may be run off on the rails, *b*, and the iron ores or ironstones may be removed or reduced at once to malleable iron, steel, or pig iron; or the cover may be kept on, and the iron ores or ironstones may be cooled and watered out under it and then removed, after which they may be reduced by the blast furnace into pig iron, or they may be reduced into pig iron, steel, or malleable iron, in kilns, ovens, or air furnaces. In lieu of using a steam jet or chimney for exhausting the gaseous matter, as hereinbefore set forth, a jet of air at high pressure may be employed by connecting the nozzle with a reservoir in which the air is compressed; the expansion of this air on escaping through the nozzle, will reduce the temperature of the condenser to the requisite degree, at the same time producing the necessary amount of draught.

Fig. 13.

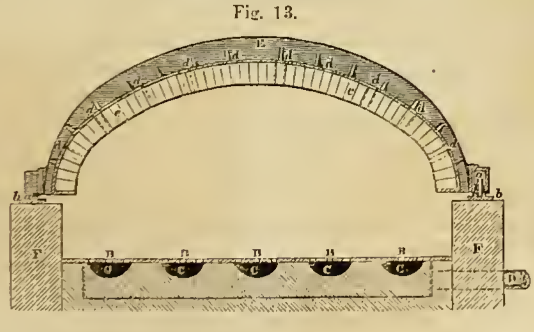


Fig. 14.

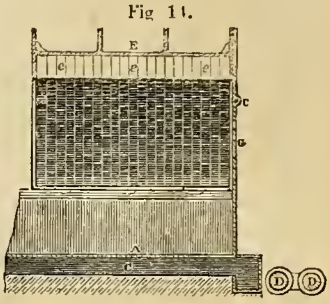
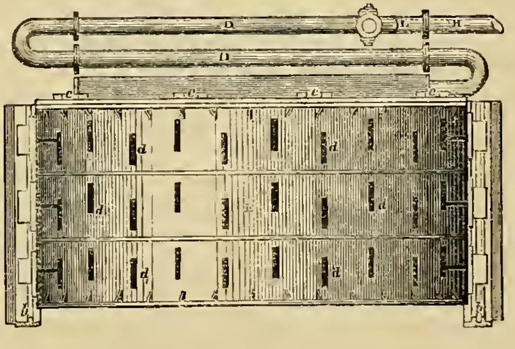


Fig. 15.



In place of treating the iron ores or ironstones in any of the apparatus or means for carbonizing them, as hereinbefore set forth, the materials to be carbonized may be placed on a frame or platform carried upon wheels, or on revolving plates or platforms, such platforms or plates being arranged to traverse on rails or trams, that they may be run under an arched covering or kiln, and therein coked or carbonized; or the process may be made continuous by feeding the raw iron ore or ironstone in at one end of the kiln, retort, oven, or arched covering, and as it is coked or carbonized, drawing it out at the opposite end; the gases and oils being utilized or collected as hereinbefore described.

SAFETY CAGES AND LIFTS.

(Illustrated by Plate 7.)

Messrs. John V. & William H. Merrick, proprietors of the well-known extensive engineering establishment of Merrick & Sons, Philadelphia, U.S., A., have recently obtained a patent in this country for some very simple forms of safety attachment, to be applied to miners' cages, lifts, and other like hoisting apparatus, which we illustrate on one of our Plate engravings for this month. Their invention consists of certain mechanism for arresting a miner's cage or other hoisting apparatus in its descent, when the hoisting rope breaks. Figs. 1 and 2 on the plate engraving represent a miner's cage with the safety attachment fitted thereto. Figs. 3 and 4 are two views of a modification of the safety attachment adapted to a hoist. Figs. 5 and 6 of the woodcuts represent another modification of the invention. In figs. 1 and 2 A represents the cage and B B′ the two permanent guiding frames, to each of which is secured a rack, *b*. To hangers, *a a*, secured to the top bar or bars of the cage are hinged two levers, D and D′, the short arms of which have teeth adapted to those of the racks, *b*. The ends of the long arms of the levers are connected by links, *e e*, to the hoisting chain or rope, F, and to the short arm of the lever, D, is connected a rope, *f*, which passes over suitable guiding pulleys, and to which is attached the weight, H, a similar rope, *f*, connected to the lever, D′, passing over guide pulleys and being attached to the same weight. In hoisting the cage the long arms of the levers, D and D′, are elevated and in contact with the underside of the crossbar, *m*, of the cage, and the teeth of the short arms of the levers, D and D′, are clear of the racks, *b*, *b*, as shown in fig. 1; but should the hoisting chain or rope break, the weight, H, will instantly raise the short arms of the levers relatively to the cage, so that their teeth will fit between those of the racks, *b*, *b*, on the guides, B B′, and will prevent the falling of the cage, as shown in fig. 2. In the modification, figs. 3 and 4, wire-ropes, M and M′, are substituted for the guiding frames and racks shown in the previously described figures, each rope passing through an opening in an extension, *m′*, of the crossbars, *m*, of the hoist. Each opening is of such dimensions above as to admit the wire-rope freely, but is enlarged below, so as to admit a wedge, *e′*, one of which is connected loosely to the short arm of each lever. One edge of each wedge is inclined and adapted to the inclined side, *p*, of the opening, the other edge being rounded to correspond to the concave edge, *p′*, of such opening. When the hoist is being raised the long arms of the levers, D and D′, are elevated and in contact with the retaining pins, *t*, *t*, and the wedges, *e′*, are depressed, so that the cage is at liberty to slide freely on the guiding ropes, M, M′. Should the hoisting chain or rope, F, break, however, the weight, H, will elevate the short arms of the lever and their wedges. This elevation of the wedges, combined with the simultaneous effort of the cage to descend, will cause a portion of the guiding ropes to be wedged tight in the cavities of the crossbeam, *m*, as shown in fig. 4, and the cage will be promptly arrested. In the modification illustrated by the woodcuts, figs. 5 and 6, bars, D and D′, are substituted for the above-described levers, these bars being arranged to slide between two crossbars, *m*, *m*, of the frame and the toothed end of each bar, passing through and being guided by a plate, *n*, on each corner of the cage, each bar near each opposite end being guided by pins or rollers, *t t*. Two three-armed levers, J and J′, are hung loosely to pins, *w w*, on the crossbeams, *m*, of the cage; the lower arm of the lever, J, being connected to the bar, D, and that of the lever, J′, to the bar, D′. The arms, *x x*, of these levers are connected by links, *e e*, to the hoisting chain or rope, F, and the arms, *y y*, of the levers by links, *q q*, to a rope, *f*, which passes over guide-pulleys, *h* and *h′*, and to which is attached the weight, H. In this modification when the cage is hoisted the bars, D and D′, are drawn inwards to an extent limited by their ends coming in contact with each other, as seen in fig. 5, and when the bars are in this position their teeth are clear of the racks, *b*, *b*; but should the hoisting chain or rope, F, break, the arms *x*, *x*, of the levers will be set at liberty, the arms, *y*, *y*, will be elevated by the weight, H, and the two bars, D and D′, will be simultaneously projected outwards, so that their teeth will fit into those of the rack, and the cage or hoist will consequently be prevented from falling, as shown in fig. 6.

FIG. 5.

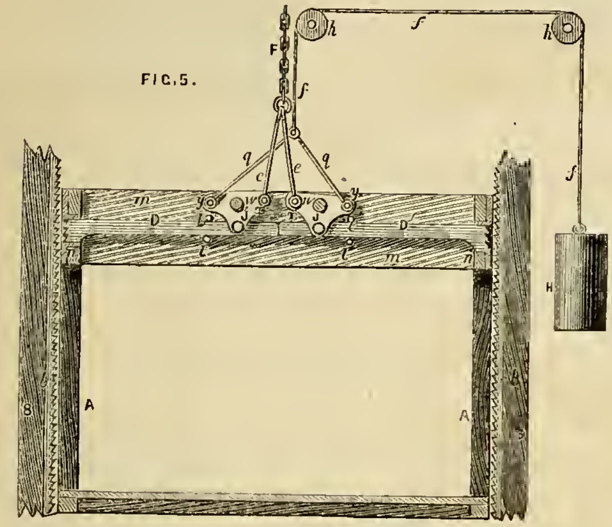
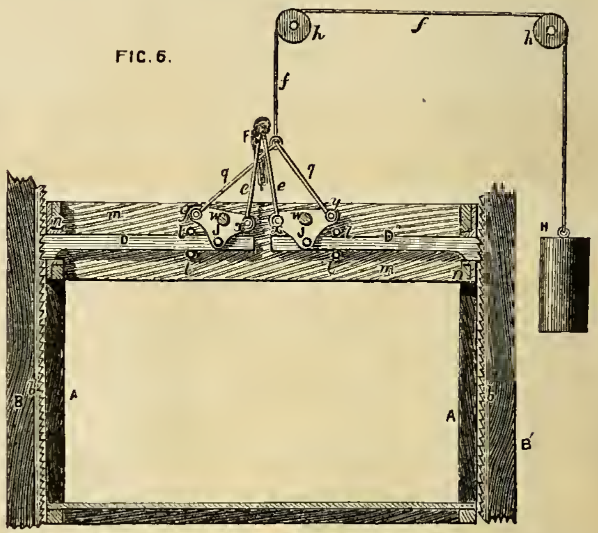


FIG. 6.



Many different devices have been applied to cages with the view of preventing accidents on the breaking of the hoisting rope or chain; cams, for instance, combined with springs, have been used for binding against guiding frames on the breaking of the hoisting rope. Cams may certainly be employed with more or less success for bearing against the smooth sides of frames; but springs are always so unreliable, that when a cage has to depend for its safety on such precarious appliances, it can scarcely be termed a "safety cage." Racks and toothed-arms or their equivalents are preferable to smooth or even serrated cams for binding against the smooth frames, as the racks insure the certain stoppage of the cage before it has acquired dangerous momentum; the racks and toothed-arms, too, arrest the cage without subjecting it and the frame to the violent strains which arresting cams are liable to impart.

It will be seen that throughout the several modifications one prominent feature prevails, which is, that the force exerted by the falling cage to raise the weight, or rather the force which, if the weight were connected directly to the cage, would be exerted by the latter to raise the weight, is exhausted in arresting the cage; the force exerted to actuate the arresting arms or rods being upwards or in a direction contrary to that of the falling cage.

STEAM-WINCH.

(Illustrated by Plate 8.)

The steam-winch which forms the subject of one of our Plate engravings this month, is the invention of Mr. Joseph Corradi, an engineer of Marseilles, who has recently secured his patent rights in this country. The striking feature of this steam-winch is its simplicity of construction and capability of standing the roughest usage. Our engraving is taken from Mr. Corradi's specification drawings; but the manufacturers in this country, Messrs. Oswald and Company, of Sunderland, have introduced some modifications in the construction which, although apparently trifling, tend greatly to increase the serviceability of the machine. These we shall have occasion to touch upon after giving a general description of the patented improvements in question.

Mr. Corradi's improvements relate more particularly to a peculiar arrangement of valve box and valve with an indicating apparatus to be used in conjunction therewith, and have for their object the facilitating the instantaneous starting, stopping, and reversing of steam-winches by the aid of a simple arrangement, which is less liable to derangement than those hitherto employed for that purpose.

Fig. 1 of the engravings represents an elevation and partial vertical section of the steam-winch. Fig. 2 is an enlarged vertical section of the improved valvular arrangement, showing the valve and valve seat for effecting the instantaneous starting, stopping, and reversing of the winch. Fig. 3 is a sectional plan of the valve seat and thoroughfares, and fig. 4 is a detached plan of the under face of the valve. A is the bedplate, upon which is supported the entire mechanism of the steam-winch; B is the main drum or barrel, deriving its motion through the large spur wheel, C, and pinion, D, the latter being carried on the main driving or actuating shaft, E, which receives its rotatory motion direct from the two oscillating cylinders, F F′, and crank pins, G G′, situate at or about an angle of 90° from each other in the discs, H H′, which are keyed or otherwise secured to the opposite ends of the driving shaft.

FIG. 1.

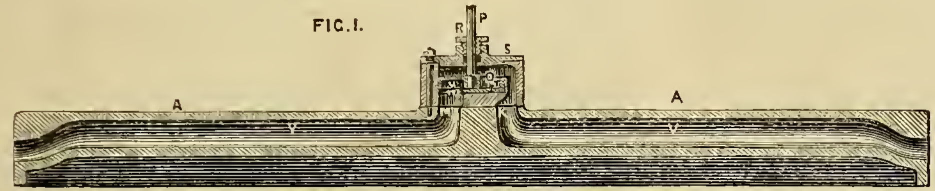
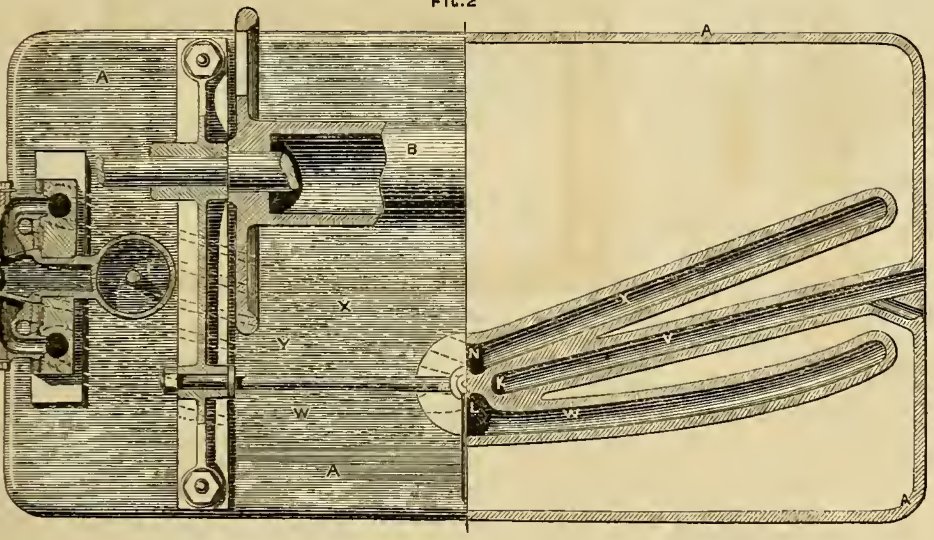
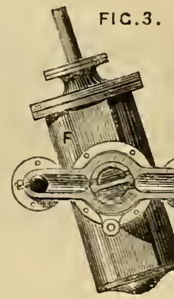


FIG. 2



In a convenient part of the bedplate, so as to be easy of access, there is bolted the valve seat, I (shown more clearly in the enlarged sectional details, figs. 2 and 3). On this valve seat are cast the four lateral flanged branch pipes, K, L, M, N. The face of the valve seat is ground perfectly true, and fits accurately the circular valve, O (fig. 4). This valve is secured to the lower extremity of a vertical spindle, P, which is supported in an upright position by the bearings, Q Q, and works through a stuffing box, R, in the lid or cover, S, of the valve box. The valve has an opening or thoroughfare, T, made on one side of its centre of motion, and a recess or chamber, U, in its working face on the opposite side of such centre. In the valve seat or face, I, there are made three apertures, *l*, *m*, and *n*, corresponding to and communicating with the respective branch pipes, L, M, and N; and the recess or chamber, U, in the under side or face of the valve should be sufficiently large to cover or embrace either the combined openings, *l* and *m* or *m* and *n*, as circumstances may require, the thoroughfare, T, in the valve being so situate as to coincide with one or other of the openings, *l* or *n*, according to the required position of the valve. The steam or other actuating medium, such as compressed air, gas, or water, is admitted to the valve by the pipe, V, which is bolted to the branch, K. To the branch, L, are connected two pipes, W; one of these pipes, shown in dotted lines, can be seen in the engraving, the other being cut away by the section. These pipes, W, severally lead to the two actuating cylinders. To the branch, N, are connected two other pipes, X, also leading into the cylinders; but one of these pipes only can be seen in the engraving. The pipes, W and X, act alternately as steam and exhaust pipes, according to the direction in which the engines are working. Y is the permanent exhaust pipe bolted to the branch, M, through which the steam or other actuating medium escapes into the atmosphere. To the upper end of the valve spindle, P, there is keyed an actuating lever handle, Z, provided with a pointer or indicator, which moves over a fixed dial or quadrant having three divisional marks made thereon. When the pointer is in a central position the steam, which has always free access by the passage, *k*, to the top of the valve, is completely shut off from the pipes, W and X, by reason of the openings, *l* and *n*, in the valve seat being closed by the valve, and the opening, T, in the valve being also closed by being situate midway between the said openings, *l* and *n*. On turning the handle, Z, so as to bring the pointer round to the division on the right hand of the dial, then the opening, T, in the valve will be brought over the opening, *l*, in the seat, whilst the two openings, *m* and *n*, will be connected by the chamber, U, in the valve. The result will be that steam or other medium will enter from the pipe, K, pass through the openings, T *e*, branch, L, and pipes, W, to the cylinders, the pipes, X, serving as the exhaust pipes, as they are simultaneously brought into communication with the permanent exhaust pipe, Y, through the openings, *m m* and U, and branch, M. On reversing the position of the valve, or bringing the indicator over to the left, the respective functions of the pipes, W and X, will be reversed, the pipe, X, then acting as the steam supply pipe, and the pipe, W, as the exhaust, thus reversing the motion of the pistons in the cylinders. In this latter case the opening, T, will be brought over *n*, and the openings, *l* and *m*, will be connected by the chamber, U; the steam will consequently pass through the openings, T *n*, branch, N, and pipe, X, and will escape after doing duty in the cylinders by the pipe, W, branch, L, openings, *l m*, and branch, M, to the exhaust pipe, Y. Each of the working cylinders, as will be seen in the drawing, has two ports or passages only cast therein, which act alternately as steam and exhaust ports, being brought by the oscillation of the cylinder into alternate communication with the pipes, W and X. Mr. Corradi's, arrangement of valve is obviously applicable to water engines, pumps, ventilators, and other like machinery.

FIG. 3.



Messrs. Oswald & Co., in making these winches, dispense almost entirely with the bolts and nuts, shown in the Plate engraving, for attaching the steam and exhaust pipes to the bedplate and valve box, by simply casting such passages in the bedplate itself, as shown at figs. 1 and 2 of the wood-cuts, which represent respectively a sectional elevation of the bedplate alone and a sectional plan, one half being taken through the left-hand cylinders and ports, and the other half through the steam and exhaust passages in the bedplate. These passages are all indicated by corresponding letters of reference to those marked on the like parts of the Plate engraving, and need no further explanation beyond mentioning that the object of the contracted orifice, U, branching from the permanent steam passage, V, is to take away the condensed water from the steam passage, a cock being fitted on to the orifice for that purpose. The arrangement and action of the steam and exhaust ports, in immediate connection with the working cylinders, will be readily understood on referring to the sectional plan, fig. 2, and the transverse vertical section (fig. 3 of woodcuts) of the same passages. The valve box, in lieu of having lateral branches with flanges cast thereon for the steam and exhaust pipes to be bolted to, has these passages cast through the bottom thereof, and is simply bolted down upon the surface of the bedplate, so as to bring the passages into correspondence with the mouths of the steam and exhaust passages cast in the bedplate, as is already shown in fig. 1. By having all the passages cast in the bedplate the risk of leakage is almost entirely avoided. The main windlass barrel is so contrived as to be readily taken out at any time, the journals being provided with removable covers on the side frames or standards for that purpose. Chain pulleys are cast on the drums of the forward winch, so that they may be used for working the windlass when necessary.

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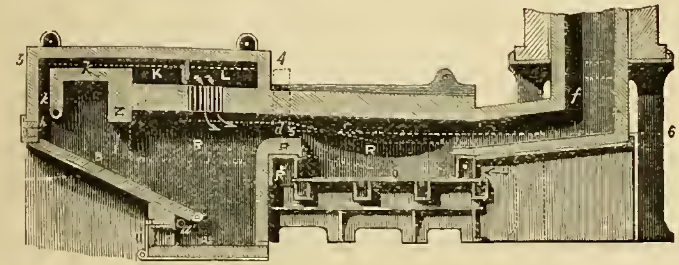
RECENT PATENTS.

IMPROVEMENTS IN FURNACES.

Edward Brown Wilson, *of Bolton.—Patent dated 29th October,* 1867.

This invention relates to certain improvements which are applicable to several varieties of furnaces, but more particularly to such as are used for puddling iron, reheating and heating purposes, chemical processes, and raising steam.

Fig. 1.



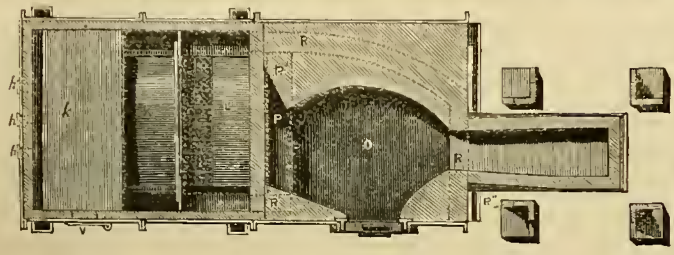


Fig. 2.

Fig. 1 of the engravings represents a longitudinal vertical section of one arrangement of the improved furnace as applied to the puddling of iron, the section being taken along the line 1–2, in fig. 2. Fig. 2 is a horizontal section of the said furnace, corresponding to fig. 1, and taken along the broken line, 3–4–5–6, in fig. 1. A is a cast-iron or other metal plate, covered with fireclay, B, and forming an inclined bed or surface for the fuel, which is fed into the combustion chamber, I, through the side door, Y. U is another plate, also covered with fireclay, forming the bottom of the furnace upon which the ashes rest U′ is a door for cleaning out the ashes from the front, and G is a door in the side for a similar purpose. An arched hanging bridge, Z, is built above the combustion chamber, and between the arched roof of this chamber and the outer roof, H, there are constructed two hot-air chambers, K and L, which are divided from each other by an internal partition and valve, or damper, N. The chamber, K, communicates through the damper, N, when open, with the chamber, L, and also communicates by the passage, *k*, with the upper part of the combustion chamber, I, at the front end thereof. The bottom of the hot-air chamber, L, is formed with perforated bricks or open brickwork, M, in order to allow of the entrance of hot air into the upper part of the combustion chamber, near the back or inner end thereof, in front of the flame bridge, P. *d* is the throat or entrance to the working chamber, *e*, the hearth of which is covered by the plate, O. F is the chimney. In the two side walls of the furnace, and in the hollow metal casting forming the sides of the hearth air conduits or passages, R and R′, are constructed, the conduit, R, passing round one side and end of the working chamber to an air inlet situate at R″, for the admission of fresh air into the conduit, R. The conduit, R′, branches off from the conduit, R, and passes along a hollow casting, which supports the flame bridge, P, and opens into an air passage made in the opposite side wall These two conduits, R R′, communicate by the openings, *r r′*, with the hot-air chamber, K, as shown in fig. 2. In order to assist combustion, air is introduced into the lower part of the furnace through an air pipe, *a*, in the side walls, by the aid of a steam jet pipe, *a′*. *h h* are apertures, provided with regulators, for admitting air, when required, into the front of the combustion chamber, amongst the fuel.

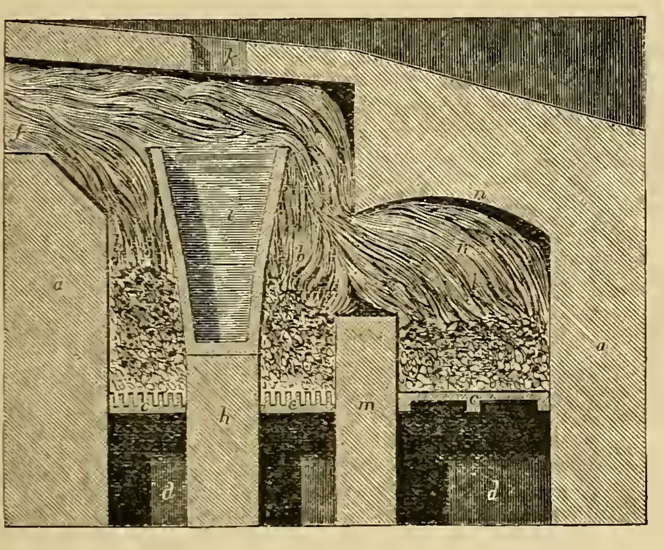
FURNACES.

Francis Ellershausen, *of Ottawa, Canada.—Patent dated 30th March,* 1868.

This invention relates to the manufacture of cast steel from pig iron, in conjunction with wrought iron or iron ore; also to the melting of blistered steel and other metals in large quantities, and in furnaces employed therein. According to this invention the furnace is divided into two fire chambers, separated by a fire bridge; the one chamber serving to contain the crucible, which is surrounded by fuel, whilst the other chamber forms a reverberatory fire chamber, the top being so curved or arched as either to direct the flame round the sides of the crucible in the adjoining chamber, or draw it into the open mouth thereof, as required. An opening is made in the roof, immediately above the crucible, to afford easy access thereto, and a lid or cover, as well as a discharge hole, are also provided for the crucible, which is of larger size than usual. In using this furnace after both fires have been brought to a white heat, molten cast iron is poured into the crucible in such quantities as will form steel of the required quality, in conjunction with malleable iron; vitreous fluxes are then introduced in order to protect the metal from oxidation. Wrought-iron scraps are then brought to a white heat in an adjoining furnace, and introduced in suitable quantities into the cast iron already in the crucible; when the cast and wrought iron have been thus mixed and melted together in the crucible, the contents are drawn off as cast steel through the discharge pipe. This furnace may also be used for the melting and refining of blistered or other steel, or for the remelting or refining of metals generally. The puddling process may also be carried on in the improved furnace by making the working hole on the top, in lieu of in the side, of the furnace; the puddling being effected by means of a ball of iron attached to the lower end of an iron bar, which is worked up and down inside the crucible by a pulley and chain or by hand. Pulverized iron ore and purifying fluxes or agents, with pulverized charcoal, are added to the cast iron by degrees through the feed hole, and worked up with the metal until it comes to "nature;" the slag is then run off through the slag hole, and the required proportion of cast iron to form the required quality of steel is added. The cover of the crucible is either put on, or vitreous flux added, to prevent oxidation of the steel whilst the blast is increased in the fire chamber containing the crucible. The cast iron last added will carbonize the pasty material, and the whole will become liquid; and after allowing sufficient time for fusing the cast steel, will be ready for drawing off.

Fig. 1 of the engravings represents a vertical longitudinal section of the said furnace, and fig. 2 is a vertical longitudinal section of a modified form of the roof of the fire chambers in the said furnace. *a* is the shell of the furnace, which may be built, in the form shown in the engravings, of ordinary bricks or stones, but lined on the inside with firebricks; it will be strengthened by an iron casing on the outer side. *b* is the principal fire chamber, supplied with coke, or anthracite coal, and provided with grate bars, *c c*, ashpit, *d d*, and side door, *e*, through which the fuel and the crucibles are introduced; *f* is the outlet from the fire chambers into the chimney, *g*; *h* is a stand for the support of the crucible, built of firebrick, and of sufficient size for any convenient dimension of crucible employed; *i* is the crucible referred to; i^1 is a discharge pipe leading from the bottom of the crucible for running off the steel or molten metal; *k* is the aperture in the roof of the furnace, immediately above the mouth of the crucible (this aperture is also made use of for the manipulating of the material in the crucible during the process of conversion); *p* is the cover of the crucible shown in fig. 2; a suitable hole situated higher up than i^1, is provided in the crucible for discharging the slag; *l* is a second fire chamber separated from the first fire chamber, *b*, by the fire bridge, *m*; this second fire chamber is also provided with the requisite grate bars and ashpit, but with an arched roof as shown at *n*; *o* is the door for the admission of fuel into the fire chamber, which in this case must consist of bituminous coal, for the purpose of creating a flame. Both of these fire chambers are supplied with air pipes from a fan blast, for facilitating the combustion.

Fig. 1.



In the modification shown in fig. 2, it will be seen that the configuration of the roof of each fire chamber, differs in some respects from that shown in fig. 1, being arched for the purpose of throwing the flame from the second fire chamber, *l*, into the mouth of the crucible.

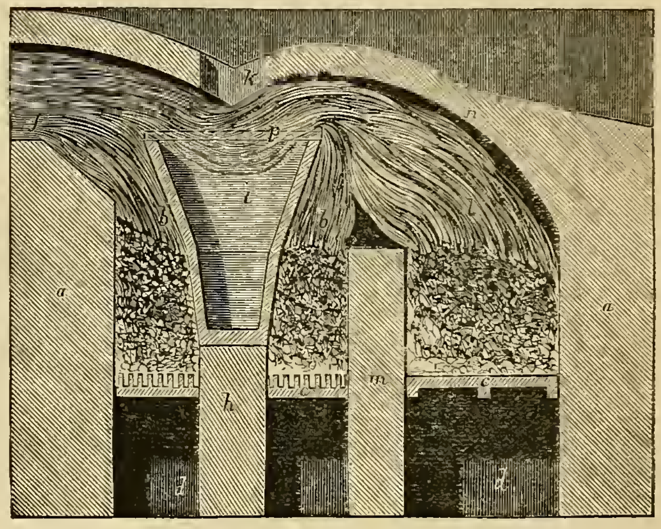
By the use of the improved furnace a degree of temperature is obtained greatly in excess of any degree of heat heretofore produced in crucibles or reverberatory furnaces used in the manufacture of steel. Thus a crucible of 2 inches in thickness, and sufficiently large to contain 1000 lbs. of metal, will convert this quantity in one-half the time now occupied in smelting the metal contained in a crucible holding about 50 lbs.; by this invention, also, the heated crucible will stand for many days work, as its temperature is not varied, and by tapping the crucible the operation can be continued without interruption.

In the first modification of furnace, shown in these figures, the *modus operandi* is as follows:—After both fires are started, and the furnace brought to a white heat, molten cast iron is poured into the crucible in such quantities as will form steel of the required quality, in conjunction with malleable iron. After the introduction of cast iron vitreous fluxes are introduced, in order to protect the metal from oxidation. Wrought-iron scraps are then brought to a white heat in an adjoining furnace, and are introduced in suitable quantities into the cast iron already contained in the crucible; such introduction being effected slowly and as fast as the same is melted by contact with the cast iron. When the proper proportions of cast and wrought iron have been thus mixed in the crucible, and the proper fusion secured, the metal is drawn off in the condition of cast steel through the discharge pipe, I, and the process is repeated.

The next and important advantage afforded by the improved furnace is its capacity for melting and refining blistered or any other steel, or any other metals desired to be remelted or refined, as this furnace will perform the same work in less than half the time hitherto required, and in far larger quantities at each operation.

In the second modification of furnace, shown in fig. 2, the well-known puddling process is adopted, with the following modifications:—The working hole is on the top of the furnace in place of the side; the puddling itself is effected by means of a ball of iron attached to the end of an iron bar, operated in a vertical direction by a pulley and chain or by hand. The crucible takes the place of the hearth, and in doing so the hearth or crucible is heated from the reverberatory fire, and at the same time assisted by the fire around the crucible, thereby producing an intense heat. When the interiors of the chambers are at a white heat a quantity of cast iron is introduced into the crucibles, the puddling process begins, and sufficient quantities of pulverized iron ore, mixed with purifying fluxes or agents, and pulverized charcoal are introduced by degrees through the feed hole, K, and worked up with the melted cast iron until the metal comes to "nature," or becomes "pasty." The slag is then run off through a slag hole in the crucible, and the required proportion of cast iron is added to form the required quality of steel. The cover is either put on the crucible or vitreous flux is added to prevent the oxidation of the steel, and the blast is increased in the fire chamber, *b*.

Fig. 2.



The cast iron last added will carbonize the pasty material before alluded to, and the whole will become liquid; and after allowing sufficient time for fusing, the cast steel is ready for drawing off.

FINISHING PAPER AND OTHER FABRICS.

Samuel Read, *of Edinburgh.—Patent dated 7th February*, 1868.

This invention has for its main object certain improvements in the glazing of paper and textile fabrics, the glazing being effected on both sides of the web at the same time, and by one continuous operation instead of requiring two series of glazing operations, one series applied to each side of the web, as at present. The glazing rollers may, if necessary, be heated to any required temperature, and it is preferred to use anhydrous heat for that purpose, in place of moist heat. The anhydrous heat may be that of heated air or ignited gas, passed into the hollow of the rollers; but the hollow of the glazing rollers may also be connected at one end with a flue or flues leading from a stove or furnace, the other end communicating with a chimney, the hot air and gaseous products of combustion passing through the rollers and escaping at the chimney. As it is desirable in continuous operations of the kind comprised under the present invention to maintain the bearings and journals of the working parts at a low temperature, this is effected by forming the brasses or bushes carrying the journals with hollow spaces in communication with a water supply, so that cold water may be circulated through them, and thus carry off any undue heat. In finishing some classes of fabrics, it is found advantageous to use pressure rollers having soft or yielding surfaces. Another part of this invention then consists in covering such rollers with a coat or casing of felt cloth, or other suitable material; or in place of fixing such covering or coating upon the pressure roller, a travelling web or felt of cloth, or other suitable material, may be employed, the surface of the felt or web travelling simultaneously with the pressure roller.

Fig. 1.

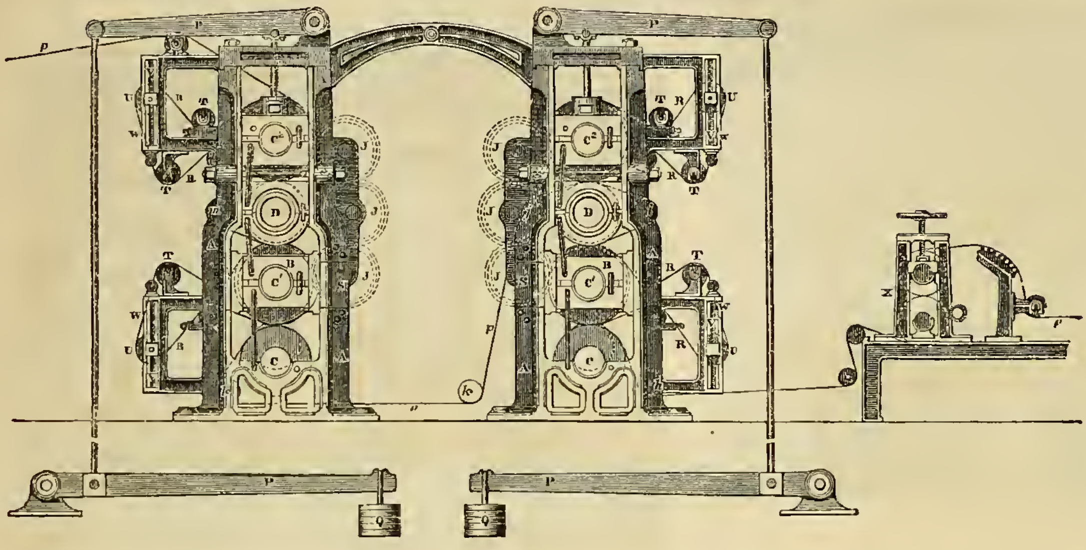


Fig. 2.

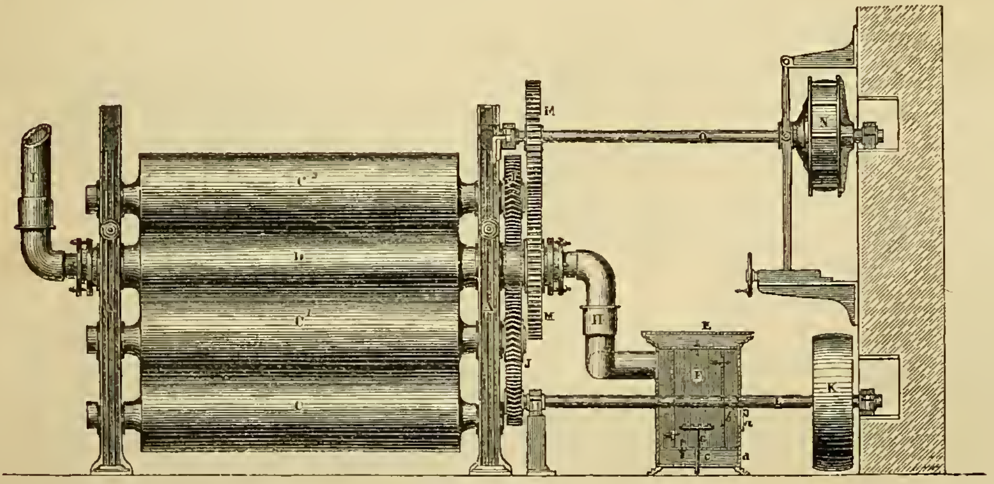
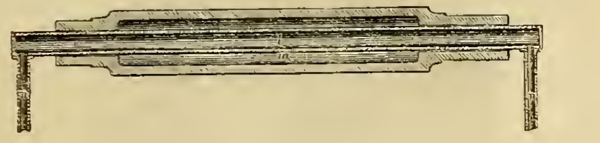


Fig. 1 of the engravings is a side elevation, and fig. 2 a front elevation, showing one of the arrangements of machinery which may be used for effecting the improved glazing operations. This arrangement consists of two sets of glazing rollers, referred to as the first and second sets. A A are the main standards or frames, in which the bushes or bearing blocks, B, for carrying the several rollers are fitted, so as to move up and down between the cheeks of the standards, A. C, C^1, and C^2 are pressure rollers, and D D are the glazing rollers, which may be used cold, or heated to any required temperature. When used hot, it is preferred to use anhydrous heat in place of moist heat. This is effected by using a stove, E, shown in section in fig. 2, having an outer and inner casing. The inner casing forms a central chamber, F, in which a gas pipe and bracket, G, is fitted. The space between the outer and inner casing is formed into passages, through which air may pass, as hereinafter described. Doors, *a b*, formed as nearly as possible air-tight, are fitted in the outer and inner casing, as a means of igniting the gas in the inner chamber, F. The mode of heating the glazing rollers, D, by means of the stove, E, is as follows:—When the gas issuing from the bracket, G, is ignited, and the inner chamber, F, heated up, air begins to pass into the bottom passage, *c*, by the holes, *d*, formed in the front of the outer casing; the air then passes into and up one of the sides, as indicated by the arrow; thence it passes into and down the front passage, *e*, which communicates with the side of the stove, not seen in the drawing, from whence the air passes into the top passage, *f*, which communicates by an opening in the top of the inner casing with the central chamber, F, so that the heated air supports the combustion of the gas or other fuel used in heating the stove. The air then passes through an opening into the back passage, *g*. During the time the air travels through the passages formed between the outer and inner casing of the stove, E, the air is raised to a high degree of temperature, and escapes from the back passage, *g*, by the pipe, H, to the interior of the glazing roller, D. The heat of the air is there absorbed by the metal of the roller, and the air passes out at a reduced temperature by the pipe, I, which may be in communication with a flue or chimney. The pressure rollers, C C^1 C^2, are put in motion by spiral, toothed, or V gearing, J, actuated by a belt operating upon the pulley, K, which is keyed on the shaft, L, fig. 2. The glazing roller, D, is put in motion by spur gearing, M, actuated by a belt operating upon the expanding pulley, N, which is keyed on the shaft, O. By means of the expanding pulley, N, the surface speed of the glazing roller, D (which in glazing operations requires to be greater than the surface speed of the pressure rollers, C C^1 C^2), may be altered at pleasure, so as to give a higher or less degree of finish to the material being operated on. If, however, it is required to finish the web by pressure and without glazing, the pulley, N, must be expanded, so as to drive all the rollers at the same surface speed, or the spur wheel, M, on the shaft, O, may be lifted out of gear; the roller, D, would then travel by pressure only at the same rate as the other rollers, C C^1 C^2. The pressure upon the rollers may be produced by means of compound levers, P, and weights, Q, as shown in fig. 1. Travelling felts, R, are placed between the pressure rollers, C^1 C^2, and the glazing rollers, D, for the purpose of forming a soft or elastic surface while glazing some classes of fabrics; or the rollers, C^1 C^2, may be covered with woven or unwoven felt, cloth, or rubber, or with rubber having one or more layers of woven or unwoven fabric on the outer surface, for the purpose of protecting the rubber from the heat of the glazing roller, D, or with other suitable material. To allow of the travelling felts, R, being conveniently taken out of the calender and replaced, and also removing the rollers when necessary, the standards, A, are formed so that a piece of the cheeks at each set of rollers may be taken out, as shown at S, fig. 1. The felts are also supplied with suitable bearing and guide rollers, T, and stretching rollers, U, actuated by screws, V, fitted in the brackets, W. The glazing operations are conducted in the following manner.—As the web of paper P, passes from the end of the paper-making machine, X, as shown, or in any other manner, it is led under the carrying roller, *h*, thence between the pressure rollers, C C^1, in the first first set of rollers, then between the pressure roller, C^1, and the under side of the glazing roller, D, where the under side of the web is partly glazed. The web is then led round the carrying roller, *i*, as shown (or if desired, a greater number of such carrying rollers may be used), from whence it passes between the upper side of the glazing roller, D, and the under side of the pressure roller, C^2, where the under side of the web receives a higher degree of finish. The web, P, is then led round the carrying rollers, *j k l*, whence it passes between the pressure rollers, C C^1, in the second set of rolls, then between the upper side of the pressure roller, C^1, and the glazing roller, D, where the upper side of the web, P, receives a certain degree of finish; or if desired, a greater number of such rollers may be used. It is now led round the carrying roller, *m*, and between the upper side of the glazing roller, D, and the pressure roller, C^2. The web, P, may now be led away from the second set of rolls and reeled in the usual manner, or in the case of paper, it may be cut into sheets; or if a higher degree of finish is desired, the web may be led between other sets of pressure and glazing rollers till the requisite degree of finish is attained. The foregoing or other suitable arrangement may also be applied at fig. 1 for the purpose of lifting the levers, P. Fig. 3 shows a mode of heating the glazing rollers by steam. To effect this, a pipe, *l*, of equal diameter is placed inside of the roller, *m*. At one end of the pipe, *l*, a steam supply pipe, *n*, is attached, and to the other end an exhaust pipe, *n′*. As the pipe, *l*, is of equal diameter throughout, no water can lodge in it, and if any steam or moisture should permeate through the pipe, *l*, it will escape at the ends of the roller, *m*, the ends of the roller being bored larger than the pipe, *l*, or the ends may be closed by stuffing boxes fitted in the usual manner. By this method the benefits of anhydrous heat are obtained. Another part of this invention consists in a method of preventing the "firing" or heating of the bearings and journals of the artificially heated rollers. This is effected by forming the bearing blocks hollow, in which the gun metal or other bushes are fitted. The block is an inclosed box, except the part into which the bush is fitted, which is cored out or left open, so that the water or other liquid with which the box is filled may be in contact with the bush, and carry off any undue heat. To provide a sufficient bearing surface for the bush, ribs may be formed, running through the bearing block, having holes formed in them to allow free circulation of the water to all parts of the block. As in course of time the water, if stationary in the blocks, might become too hot to keep the bushes and journals sufficiently cool, a constant stream of water is kept circulating through the bearing blocks. This may be effected by connecting the upper bearing block to a cistern or reservoir of water, and connecting the blocks to each other.

Fig. 3.



PRINTING TRADE-MARK CAPSULES.

William Betts.—*Patent dated* 18*th February*, 1868.

This invention has for its object the production of trade marks, letters, or other devices, in a simple and efficacious manner, upon one or more parts of the cylindrical or conical surfaces or sides of metallic capsules intended for covering the necks of bottles and other like receptacles.

Fig. 1 represents a plan of the improved printing apparatus, and fig. 2 is a separate view of the rolling mandril used in connection therewith, with a capsule upon it. A is a bedplate or chase provided with raised rectangular ledges, *a a′*, and with lugs, *b b* and *b′ b′*, through which work the tightening or set screws, *c c* and *c′ c′*, which, by the aid of suitable slips of wood, *d d*, are made to tighten or secure in proper position the original printing surface or surfaces, *e e*. These may consist simply of stereos taken from wood blocks engraved to the required design, or they may consist of type set up in the chase to produce the words required. In lieu of such type or device being reversed, as is the case when the impression is to be taken direct from the type or printing surface itself, such printing surfaces or type may be made so as to present the same appearance, or to read the same way, as the impression taken on the capsule; as the impression is not taken direct on to the capsule from the printing surface itself, but an impression is first taken on the smooth surface of a piece of vulcanized india rubber, B, or other suitable yielding or elastic material, and then transferred on to the side of the capsule itself in the manner explained below. This elastic printing surface, B, is let into a plate, C, hinged at D D, on the centre pins, *f f*, so as to be capable of being turned over in order to bring the surface, B, down upon the type or printing surface or surfaces at *e e*, for the purpose to be presently explained. To the board or table, E, which carries the entire apparatus, there are hinged the adjustable gauges, F F′, which are made to fold over the india rubber or transfer surface, B, and to turn back again out of the way, the object of which will be clear on describing the mode of using the apparatus. Supposing it to be desired to produce, for example, a trade-mark capsule with the letters and device on the side in dull or "mat" colours; a coating of boiled oil is first applied to the printing sufaces, *e e*, by the aid of an india rubber or other suitable roller, and then the plate, C, is turned over, so as to bring the face of the india rubber surface, B, down upon the printing surfaces, *e e*; this has the effect of preparing the surface of the india rubber for the reception of a subsequent impression in gold size, which is afterwards applied in a similar manner to the oil on to the printing surface or surfaces, *e e*, but the patentee prefers to mix a small quantity of boiled oil with the size employed. The plate, C, is then again turned over on to the printing surfaces, *e e*, and a reversed impression is taken on the india rubber. This impression has now to be transferred to the side of the capsule, which is accomplished by rolling the capsule over it. For this purpose a conical or tapered roller, G (fig. 2), of hard wood is employed, of a shape exactly conforming to that of the capsule to be operated upon, and fitted on to a slightly tapered spindle, *g*, fixed at one end only in a holder carried by a handle, *h*; a nut, *i*, on the outer and smaller end of the spindle serves to tighten up the roller, G, and counteract any tendency to undue looseness which might arise from wear and tear of the parts, whilst at the same time, however, the roller should be allowed to revolve freely. The surface, B, having received the impression in gold size, as already described, the metallic capsule is placed upon the conical roller (see fig. 2) and rolled carefully over the impressions on the surface, B, taking care that the capsule is so placed at starting as that the impressions shall come exactly in their proper places thereon. For this purpose the adjustable gauges, F F′, are used, the one, F, serving to adjust the position of the roller on the surface, B (as shown by the dotted lines in fig. 1), and the other acting as a stop to arrest the further motion of the roller so soon as the capsule has completely passed over the impression on the surface, B, thereby preventing any portion of the size being retransferred accidentally from the capsule back again on to the india rubber surface. If the capsules were cylindrical they might obviously be rolled in a right line over the impressions which would be square therewith; but as the capsules to be operated upon are slightly tapered, they describe a curvilinear course over the surface, B, as shown by the

Fig. 1.

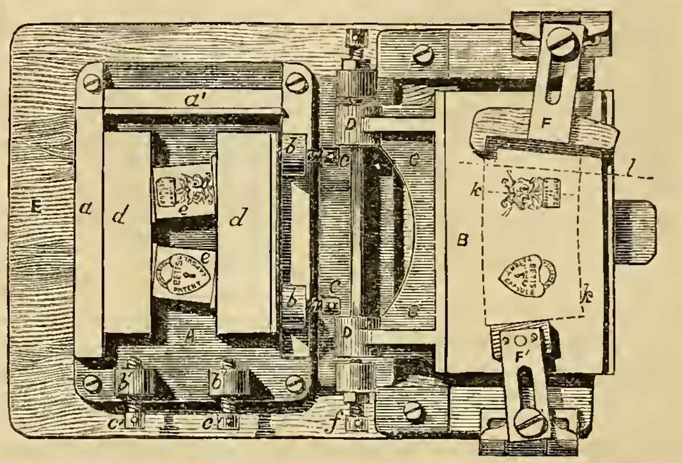
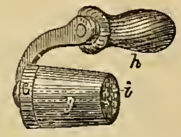


Fig. 2.



dotted lines, *k k*; and consequently, at starting, the axis of the roller and capsule must be in the direction of the radius, *l*, of the said curve, to insure which in a ready manner the gauge, F, is set accordingly. In order that the device produced on the capsule shall have its centre line coinciding with the longitudinal centre line of the capsule, it is necessary to place the printing blocks or surfaces, *e e*, at a slight angle, as shown, so that the centre line or lines thereof, when impressed on to the surface, B, shall coincide with the radii of the curve, *k k*. The impression having thus been produced, in gold size or other suitable adhesive material, upon the capsule, metallic powder or foil is applied thereto, or dry colouring matter in the form of a powder, and after removing the superfluous powder or foil, the design will be left distinctly visible on the capsule.

If preferred, oil colours may be substituted for the size and dry or powdered colours or foil, the impressions being transferred from the india rubber surface, B, to the capsule in the same manner as that described for the transfer of the gold size; or the impressions may be applied on to the capsule direct from the original printing surfaces without the intervention of the transfer surface, B. In this latter case the type or printing surfaces will, of course, be required to be reversed as for ordinary printing.

In lieu of applying the colouring matter or size direct on to the original printing surface, *e*, it is sometimes proposed to apply it on to a smooth surface of india rubber, and then to transfer the same to the type or original printing surface by pressing the india rubber surface thereon. By this means a more even and regular coating or film upon the original printing surface is obtained than can be secured by the direct application of the roller to the printing surface itself. When type is used it is to be set up in the chase, A, and tightened up against the ledges, *a a′*, by screws, *c* and *c′*, and strips or filling pieces, *d*, suitable for the purpose.

MELTING AND HEATING METALS.

ADOLPHE PERROT, *of Paris.—Patent dated* 25*th January*, 1868.

THIS invention relates to certain peculiar constructions, arrangements, and combinations of apparatus for effecting the melting and heating of metals and other substances by the aid of combustible gas or gases, mixed with a suitable proportion of atmospheric air or of oxygen.

The improved melting apparatus consists of two parts; viz., 1st., the furnace *proper*; 2nd, the combustion apparatus or burner, which may also be applied to heating in general.

The principal advantages of these apparatus are, 1st, The highest temperatures may be obtained without the use of blast engines or compressed air. For melting gold, copper, white or gray cast iron, a draught obtained by a flue-pipe of from 6 to 9 feet in height is quite sufficient, thus admitting of the erection of the melting apparatus on the upper floors of ordinary houses without regard to atmospheric conditions. 2nd, The use of gas at the ordinary pressure adopted for illumination. 3rd, Coal, and consequently cinders, are dispensed with. 4th, The whole of the metal can be saved in the case of the fracture of the crucible. 5th, The cast iron may be withdrawn without extinguishing the fire. 6th, Facility is afforded for the regulation of the temperature, and for maintaining it fixed for any length of time by simply adjusting or cutting off the supply of gas to the apparatus, as may be required. 7th, No attention or feeding are requisite during the melting. 8th, The crucibles not being in contact with coal or cinders wear only from the interior to the exterior by the re-agents, and are consequently much more durable. 9th, Considerable saving in fuel is effected, the whole of the heat being in the centre of the furnace itself, and the time required to make the casting is greatly reduced. The inventor does not limit himself to the use of illuminating gas, as any combustible gas may be employed; and in lieu of air for the combustion apparatus, pure oxygen, or oxygen mixed with any other gas, or with air, may be used. In some cases combustible gases may be introduced separately or in combination, under a suitable pressure, on to such portion of the burner or furnace as shall be deemed most convenient.

The gas is introduced through the tube, *a* (fig. 1), provided with a cock, *b*, which serves to regulate its supply to the apparatus; the plug of this cock carries a pointer, *b′*, which indicates on a dial the degree of opening of the cock. The gas passes into the horizontal annular chamber, *c*, provided on the top with any convenient number of gas jets, *d*, each of which enters the lower end of a curved pipe, *f*, shown in full size at fig. 2. These pipes are surrounded by movable collars, F, fitted so as to turn easily round them, in order to close more or less the square, round, or oval aperture, *e*, which corresponds to a similar opening formed in the collar, F. By turning this collar a certain quantity of the external air is caused to enter through the aperture, *e*, or its supply is entirely intercepted. The pipes, *f*, are straight for some distance, and then bent round so as to enter at an angle of about 45° the horizontal ring or annular frame, *h*, and each terminates in a mouth-piece, *g*, into which it fits; through this mouth-piece, *g*, which is secured by a pin to the ring, *h*, the mixture of air and gas passes out to be conducted to the melting furnace. The ring, *h*, is supported on feet, *n*, and is provided with a cross piece or bar, *l*, which supports the vertical tube, *k*; in the tube, *k*, is a cylinder, *k′*, terminating in a flange or flat head, on which is placed the block of refractory clay, *i*, intended to support the crucible containing the materials to be melted. By means of the screw, *m*, the height of the crucible in the furnace may be varied as required.

Fig. 1.

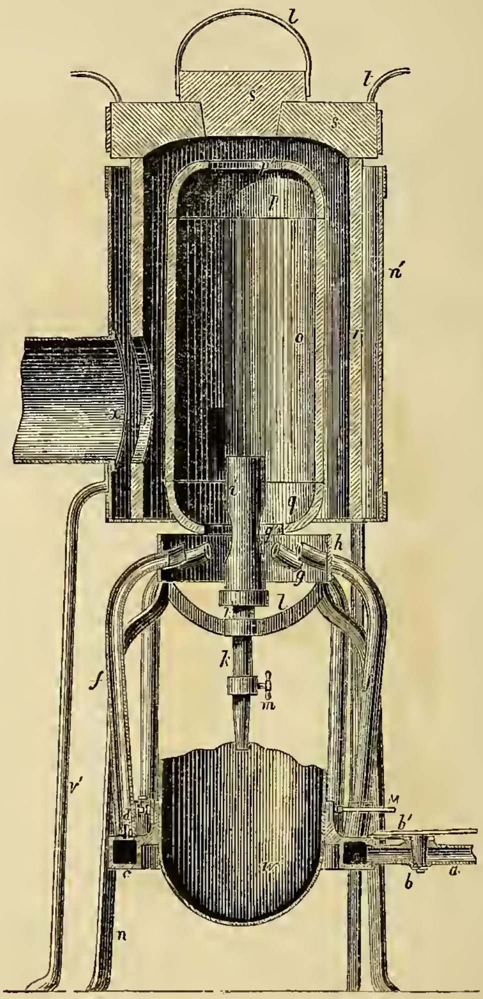
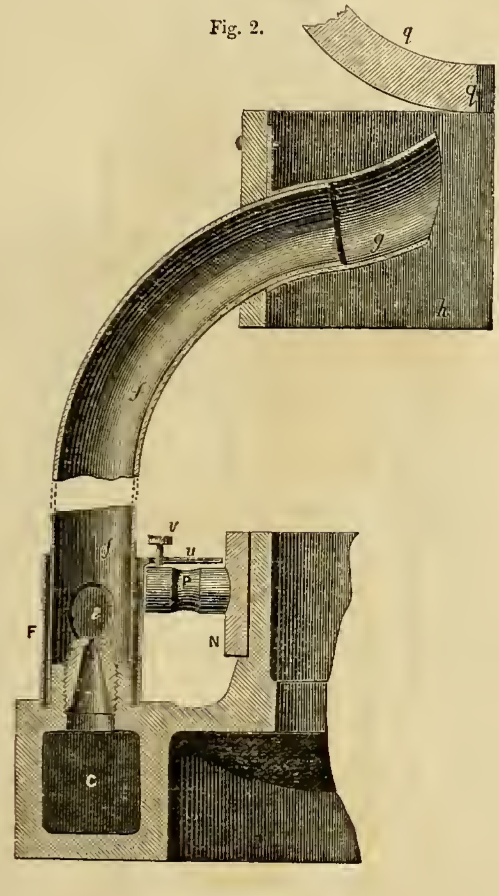


Fig. 2 shows, on an enlarged scale, the connection of the pipes, *f*, with the ring, *h*, and annular chamber, *c*. The collars, F, carry a horizontal projection or arm, *u*, on the side adjacent to the ring, N, such projection or arm being slotted to receive a pin or screw, *v*, with which the projections, P, are provided. It will thus be seen that by turning the ring, N, the degree of opening or closing of all the apertures, *e*, is regulated, by which means the admission of air into the tubes, *f*, is mathematically adjusted for its admixture with the gas.

The melting furnace is composed of a cylindrical muffle, *o*, rounded both at top and bottom, as shown at *p* and *q* (fig 1), and intended to reflect the heat on to the crucible as in a reverberatory furnace: these parts are provided with openings, *p* and *q*. The muffle is surrounded by a cylinder of refractory clay, *r*, which is formed with an aperture, *r′*, communicating with the chimney. The muffle and the cylinder, *r*, are supported on an iron base, and surrounded by a sheet-iron envelope, communicating with the chimney by the aperture, *x*; the feet, *v*′, support the whole of the melting apparatus. The draught of the chimney is regulated by a valve, on the spindle of which there is fitted a pointer, *z*, to indicate outside the position of the valve. A stove may, if desired, be disposed in proximity to the envelope, into which the gases may pass before escaping through the chimney, and which would serve to heat up the crucibles and ingot moulds. The cylinder, *r*, is closed by the cover, *s*, which may be removed by the aid of the handles, *t*; this cover is provided with an opening of about the same diameter as the aperture, *p*′, and which is closed by the plug, *s*′, strengthened by a metal collar carrying the handle, *t*′. The aperture in the cover is intended to facilitate the inspection of the melting operation, and for the feeding of the crucible with materials to be melted, and with re-agents. The chamber, *w*, is provided for the reception of any of the molten metal that might escape in the case of the fracture of the crucible.

Fig. 2.



In many manufactures it is necessary that the articles, which it is required to expose for a certain length of time to a high temperature, should be preserved from contact with the flame; for this purpose they are placed in a muffle, the form of which varies according to the shape of the article it is required to contain. A muffle, to be used by enamellers, is hereinafter described, this description being common to all furnaces provided with muffles, from those used for the assaying of gold and silver to the largest kilns for earthenware and porcelain; the same principle may also be applied to the heating of bakers' and other ovens.

Fig. 3 is a longitudinal section of a muffle, and fig. 4 a transverse section of the same. The muffle, A, which may be of any form whatever, is surrounded by a casing, *o*, the opening of which is of corresponding form, in cross section, to that of the muffle, but the opening at the other end is of a reduced size; the envelope, *r*, incloses the whole, in such a way as to leave a space between the casing, *o*, and the muffle, A. The blocks, *a* and *o*, support the muffle and its casing, and admit of the proportioning of the clear spaces in the part corresponding to the closed end of the muffle. Orifices, *x*, x^1, x^2, x^3, x^4, are provided in the envelope, *r*, for the escape of the products of combustion; the position of such orifices will vary with the form of the muffle, and according as it is required to heat it uniformly, or more or less in a horizontal part. The part, *r*, of the furnace is of unbaked clay. The aperture which the plug, *t*, closes is provided to facilitate an inspection of the traverse of the flame; this aperture is formed in a door which closes the front opening of the furnace. The casing, *o*, which surrounds the muffle, from *q* to *q*′, projects from the furnace, as shown in fig. 3. The combustion apparatus, or burner, is of the same construction as that shown in fig. 2 for the melting furnaces, its form only being varied. The tubes, shown dotted, which conduct the mixed gas are so arranged that the flames will issue therefrom in a horizontal, or nearly horizontal, direction; the form of the block, also dotted, in cross section should correspond to that of the opening, *q*′, and it is intended to act as a closing apparatus to regulate the column of air which enters the furnace with the flames from the burner; its position may be regulated by turning an adjusting screw, which moves in a horizontal direction. The muffle may be perforated, if required, both on its rounded portion and on its sides; such perforations, by reason of the draught, only afford an outlet to the products of calcination and to the air, and not to the ignited gases.

Fig. 3.

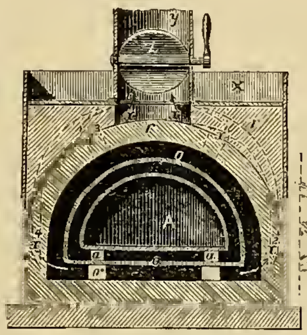
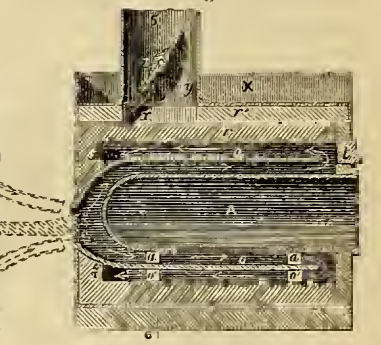


Fig. 4.



The muffle furnaces require a greater draught than melting furnaces, such as shown on fig. 1. The muffle furnace (requiring greater draught than the melting furnace) is provided with a chimney, *y*, in which is mounted the valve or damper, *z*, to regulate the draught. The part, X, of the furnace may be used as a dryer.

MOULDING MACHINERY.

William Simons and Archibald Carmichael, *Renfrew.—Patent dated 17th December*, 1867.

This invention has for its essential object certain improvements in moulding, and consists in the construction and arrangement of the machinery or apparatus for facilitating moulding operations in the production of castings in iron, brass, and other metals. The apparatus consists of an inner frame or tube, which may be either rectangular, circular, or other shape or configuration; which frame is hung loose and revolves upon a stationary shaft supported in suitable brackets, or in any other convenient manner. Attached to the periphery of this inner frame are the moulds or patterns of the castings desired to be produced, which may be one, two, or any convenient number, according to their size. On the same shaft on which the inner tube is hung, two eccentrics are keyed or forged, and on these fixed eccentrics an outer frame or tube is hung loose, and is capable of revolving simultaneously with the inner tube, by means of shafts or stays which pass through the frames: on these shafts or other convenient position eccentrics are keyed, and these eccentrics are, by preference, grooved to work in bushes constructed to fit the grooves. The bushes have clips attached to them, by which the moulding boxes for containing the sand are held against the flanges of the outer frame, and lowered by means of the eccentrics worked by levers, when it is necessary to remove the boxes after the moulds have been formed. The bottoms of these boxes are made to slide off when it is necessary to fill them with sand. The motion of the inner frame or tube, to which the moulds and patterns are attached, is circular; but the motion of the outer frame or tube is eccentric, causing the moulding boxes to be pressed against the patterns which are attached to the inner frame or tube, and a duplicate of the pattern is produced ready to be run with molten metal. The eccentric motion of the outer frame or tube is such as to cause it to turn by its weight, assisted by the weight of the sand in the boxes, after an empty box has replaced one in which a mould has been formed. Sand may be supplied to this apparatus in various ways, but we prefer to use an Archimedian screw for the purpose, one end of which is placed in a box into which the sand is emptied, and from which it is raised by means of the screw-blade to a hopper situated above the machine; a slide-plate is placed in the bottom of this hopper, which may be worked by an attendant or actuated by the revolving motion of the moulding machine, so as to supply the requisite quantities of sand to the moulding boxes. Another advantage obtained by using the Archimedian screw is, that the sand which has been used in moulding may be used over again successively, by being passed through the screw, which causes it to be thoroughly crushed and disintegrated in its passage to the moulding machine, thus effecting a very considerable saving in moulding operations.

Fig 1.

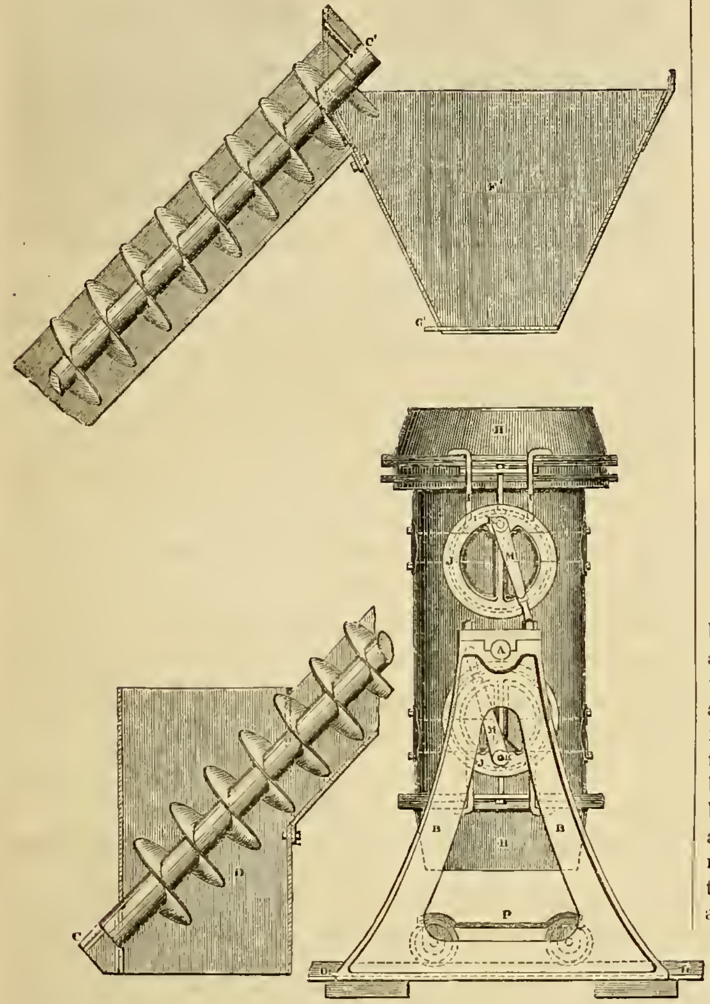


Fig. 1 of the engravings is a side elevation; fig. 2, a vertical longitudinal section; and fig. 3, a horizontal section through the outer and inner tube. A is a fixed shaft supported in the frames, B B. C C are eccentrics keyed on the shaft, A; the centres of the shaft, A, and eccentrics, C, being in the same vertical plane, so as to have the eccentricity or throw on the upper side of the shaft, A. D is the outer tube which revolves upon the eccentrics, C, and E the inner tube which revolves upon the fixed shaft, A. On each end of the inner tube, E, the patterns of the castings to be produced are fixed as shown in fig. 2; a sleeper chair, F, for railways being represented on one end, and three common railway chairs, G, on the other end. The boxes, H, in which the moulds are formed are attached to each end of the outer tube, D, by the hooks or clips, I, two of which are placed on each side of the boxes, H, as shown in fig. 1, and the heads formed T-shaped, so as to slide in the T-grooves formed round the periphery of the eccentrics, J, as shown in fig. 2. The eccentrics, J, raise and lower the moulding boxes, H, and are fixed on shafts, K K, carried in bearings formed in the outer tube, D. The shafts, K K, pass through vertical slots, L, formed in the inner tube, E, so that it is made to revolve at the same time as the outer tube, D; but the shafts, K K, partaking of the eccentric motion of the outer tube, D, pass up and down in the slots, L. M M are levers keyed on the shafts, K K, by which the attendant turns the eccentrics, J. Openings, N, are formed in the tubes, so that they may be heated in any convenient manner, to warm the patterns; or the shaft, A, may be tubular, and steam or hot air may be introduced through it. The action of the machine is as follows:—For convenience in bringing forward and removing the moulding boxes, H, the machine is placed over a line of rails, O, and the boxes brought forward and removed on trucks, P. The patterns of the castings to be produced having been fixed on the end of the inner tube, E, as shown in fig. 2, the clips, I, are lowered by turning the eccentrics, J, with the lever, M. A box, H, is now brought forward on the truck, P, the attendant turns up the lever, M, and the box, H, is lifted by the clips, I, until the flanges of the box, H, meet the flanges of the outer tube, D. The machine is now turned round, the inner tube, E, moving in a circle, and the outer tube, D, eccentrically, as hereinbefore described. The workman now fills in the sand in which the mould is to be formed, and puts on the sliding bottom of the box, H; during this operation another attendant attaches another box, H′, to the other end of the tube, D, and secures it in the manner hereinbefore described. The machine is now turned round, and by means of the eccentrics, C, causing the outer tube, D, to be drawn up, the inner tube, E, the sand in the box, H, is pressed firmly against the pattern, F, and the mould is thereby formed. The lever, M, is now turned, and the box, H, lowered by the eccentrics until it rests on the truck, P, on which it is removed. Another box is brought forward to replace the one that has been removed; during these operations the box, H′, is supplied with sand ready for the next revolution of the machine. The Archimedian screw, for supplying the sand to the machine, may be placed at any suitable angle and supported at each end in bearings, C C, as shown in fig. 1. The lower end of the screw is placed in a box, D, which is connected by a trough, E, with the hopper, F, placed immediately over the moulding machine. The sand is filled into the box, D, and by revolving the screw, A, the sand is carried up by the blade and emptied into the hopper, F. A slide plate, G, is placed in the bottom of the hopper, F, which is withdrawn by an attendant, and the sand allowed to pour into the moulding box till it contains sufficient to form the mould: the slide plate is then replaced. Although in the

Fig. 2.

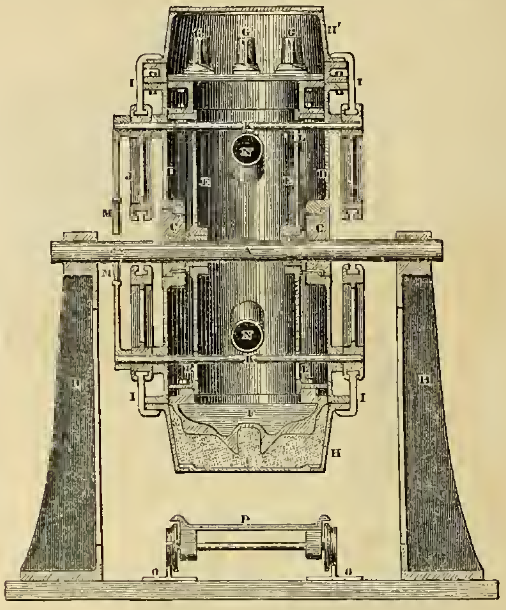
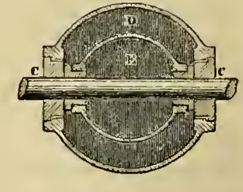


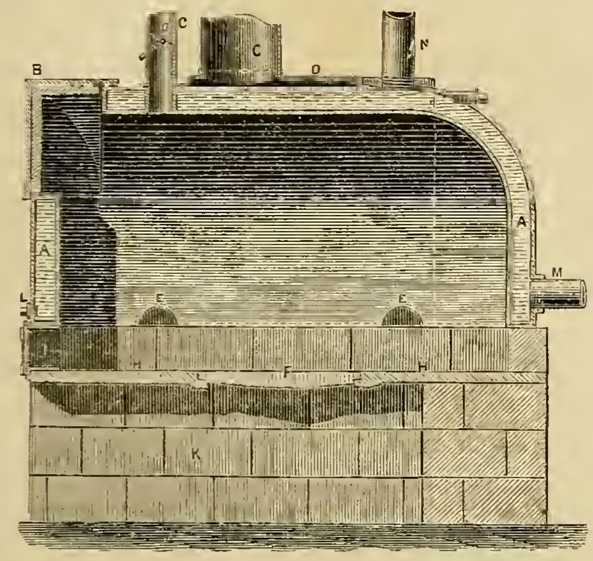
Fig. 3.



accompanying engravings the moulding mechanism is shown as applied only to moulding railway chairs and sleepers as one example of its application, it is obvious that the same or generally similar arrangements of mechanism are applicable to the moulding of numerous other articles.

REGISTERED DESIGN.

Saddle Boiler.—Mr. David Davis, of Kensington Nursery, Bath, has registered a new design of saddle boiler for warming greenhouses and other buildings, heated with hot-water pipes. The engraving represents a longitudinal vertical section of the boiler. This boiler is closed at both ends, and has a water space, A A, formed in the ends, as well as at the sides and top. A fire-door, B, is provided at the upper part of the boiler, at one end thereof, opening partly through the arch, and partly through the end of the boiler, in lieu of being formed at the bottom as heretofore.



A second or additional smoke pipe, C, is fitted on to the arch of the boiler, and provided with a damper, *a*, the object of which is to secure a quick draught after lighting the fire, or at any time when an extra strong draught is required. The main flue, D, which is formed outside the boiler, communicates with the lower portion of the fire by four apertures, E E, two of which are situate on each side of the boiler, about 3 inches above the fire-bars, F. G is the main chimney situate on the top or arch of the main flue. By this arrangement the whole of the external surface of the boiler, with the exception of the two ends, is exposed to the action of the fire. H H are dead plates, I is a clinker door, K is the ash-pit, L L are removable plugs screwed into openings for facilitating the cleaning of the boiler, M is the cold-water inlet pipe, and N is the hot-water circulating pipe The parts of the design which are new and original are those marked A *a*, B C, and E.

REVIEWS OF NEW BOOKS.

Bullion and Foreign Exchanges Theoretically and Practically Considered, followed by a Defence of Double Valuation, with Special Reference to the Proposed System of Universal Coinage. By Ernest Seyd. London, Effingham Wilson, Royal Exchange. 1868.

There are few questions of more commercial and possibly social importance to a trading community than those connected with the exchanges and currencies of this and other nations. They constitute, however, a dry if not repulsive course of study, and hence are not popular. Unfortunately, too, their consideration is not, as a rule, included in the curriculum of instruction at our public and private schools. Such information upon them as is possessed by commercial men generally, is usually obtained by actual experience, and results from necessity rather than choice. Perhaps a time will come when this state of things will be changed, and when the youth of England shall be sent forth into the world of business with at least an elementary knowledge of the true principles which govern the science of exchanges and the currency laws. Until some such reformation as this in our educational system be inaugurated, books like those of Mr. Seyd must be of the greatest value. The author of the work under notice very modestly disclaims all pretensions to elegance of style in the volume which he has placed before the public, and very properly relies for its success upon its plain and practical character.

The first chapters are devoted to explanations of the media of exchange, and they are undoubtedly replete with valuable information, based upon indisputable data. Subsequent divisions of the work are appropriated to gold and silver bullion, with minute and elaborate—would that we might add correct—accounts and descriptions of the various processes and manipulations through which those metals pass in the course of their conversion into current coin.

It is deeply to be regretted that the author, in concocting this latter section of his book, did not call to his assistance some one better qualified than he is himself for instructing the public in relation to coining operations. Chapter 21 professes to describe money-making as it is carried on at the Royal Mint, Tower Hill, but the mis-statements made are abundant, and ludicrous in the extreme. Were it desirable to occupy so much of our space as would be necessary for the purpose, nothing would be easier than to expose the errors committed in this direction by Mr. Seyd. Since, however, many chapters on Coin and Coining have appeared in these columns during the last year, and in which reliable information on that subject has been furnished, it is not essential to particularize the blunders to which we refer. It is amusing to note that the author, not satisfied with demonstrating his innocence of all knowledge of practical mechanism by giving laughably inaccurate descriptions of the Mint machinery, actually ventures upon suggestions for the improvement of the latter! His argument in favour of the lever over the screw coining press is at least original—the former "takes up comparatively little room; the lever is worked inside a powerful iron frame by a small fly-wheel at the side, which lifts it (query, the iron frame?) with every revolution." There is some consolation in the fact that in spite of the shortcomings of the English Mint, with its "old-fashioned, clumsy machinery," the conductors of the establishment "compete successfully with other mints in the execution of the coinage intrusted to them." Nevertheless improvements are needed, and in order to effect these our author recommends that the "British Mint establishment—premises, buildings, plant, machinery, and all—*be sold*," and that a new mint, worthy of the country, be erected with part of the purchase money. This is literally a sweeping proposition, and it is only to be regretted that it comes from a quarter so manifestly incompetent to judge of the value of its realization.

The author of "Bullion, Foreign Exchanges, &c.," would do well, should his work reach a second edition, to excise his chapters on coining.

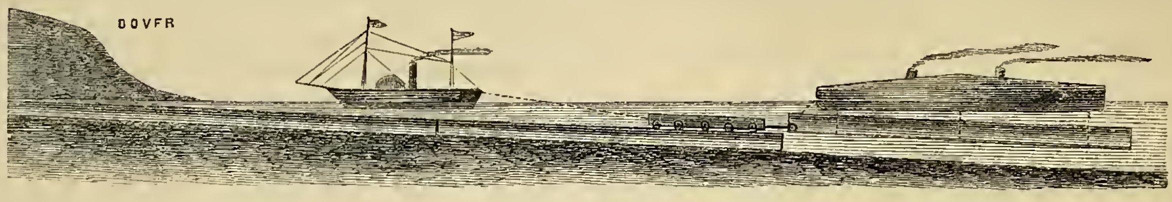
CORRESPONDENCE.

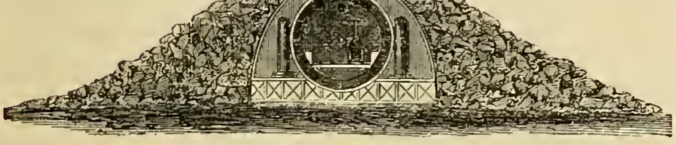
☞ We do not hold ourselves responsible for the views or statements of Correspondents.

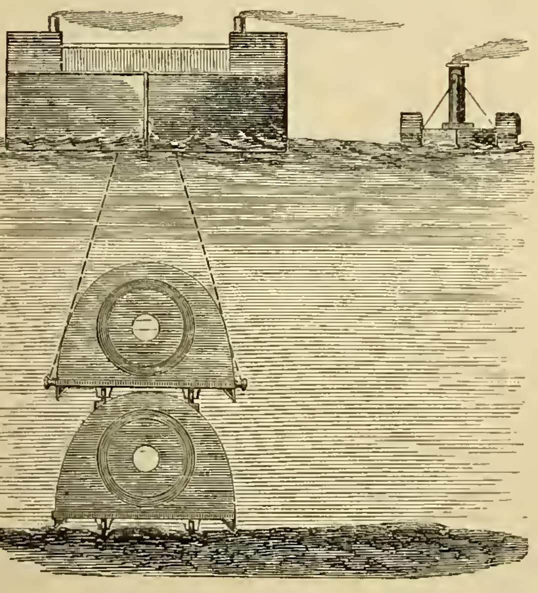
SUBMARINE TUNNEL FOR THE CHANNEL.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—Taking it for granted that the bed of the Channel is slightly uneven—although we have every reason to believe that it is so uniform and even that without levelling, and supposing it to be on *terra firma*, it would be an easy matter to lay down sleepers and rails—it becomes a question how far we may consider it practicable to lay down a line of rails for the locomotive system of transit, in company with another set of rails, so as to rapidly construct underneath the water a strong and permanent structure, whereby the long-pending question of uniting the railway system of Great Britain with that of the Continent may not be delayed. In the first place, I consider it quite essential that such a line under the sea should be double, like ordinary railways, so that we may be able to shunt from one line of rails to the other when the metals are undergoing relaying, as with every-day practice. Firstly, I consider, for wrought-iron submarine tunnels, there should be one large tube containing both sets of rails. This tube should be made double, and strongly united together with truss-work on plain plating radiating to the centre, the space between the tubes being filled with suitable material, concrete, &c., or may be left void, in which case, I consider, the outer shell should be protected with wood planking carefully caulked and tarred all over; but this will depend upon the means adopted for permanently holding down the structure. Secondly, I consider all such works should be protected, in case a vessel should sink and rest on the structure, that the inner tube may not be damaged; it would be necessary therefore to protect the inner tube with an outer casing, an eliptical form being adopted, the bottom being quite flat, strengthened with lattice girders, bulkheads, and braces, securely uniting the inner and outer shells together. Thirdly, on the top of the outer shell would be laid down a set of grooved rails, and the bottom of the structure fitted with cast-iron wheels, with shafts running in lignum vitæ bearings, similar to the "Morton" slip for hauling up vessels high and dry, the only difference being, that the tubes, say 600 feet long, would be run down an incline of about 1 in 500 to the bottom of the Channel. To expedite the laying of these tubes a travelling carriage would be necessary, the carriage being attached to the tube by means of a long link on each side, or otherwise, so connected that it could easily be detached from the tubes when sunk. To support these tubes in mid-water a large vessel, similar to a floating dock, having the necessary lowering machinery, &c., would be required, so that when one tube on shore had been laid, another being floated and sunk over it, the carriage connected, and the large floating dock would steam away slowly. When approaching the end of the first tube (marked with a buoy), the tube being suspended at three points from the dock could then be lowered and guided into its position; the paddle ship in attendance hauling the carriage up the incline. Thus the tube would be drawn close up to the one last deposited, and the bottom of the tubes being fitted with a ridge and furrow would be held together until firmly bedded at the bottom (should the bottom prove uneven hydraulic piles could be used so as to temporarily support the structure). The tubes having been sunk, either by lowering the chains or letting water into the vessel supporting the tubes, a temporary joint must then be made between the two. This would be done with a large ring fitted between the two inner shells, pressing up against an elastic medium fitted to the tube last sunk; this packed ring would be forced against the tube with hydraulic pressure contained in the adjoining tube. Of course the ends of the tubes would be perfectly water-tight, a bulkhead or temporary cover being fitted; then a communication could be made between the two tubes, and the two firmly bolted together. The bulkhead could then be removed, and an additional permanent joint made, with a ring of wrought iron rivetted to both; thus, with the bolts and rivets, the tubes would be firmly united together. To cast off the chains, and haul the carriage up the incline for another tube, would then become a thing of daily occurrence until the whole structure was laid, which I consider it quite practicable to effect from one end, namely, at Dover, as the tubes would merely be loaded sufficiently to run lightly on the metals. I consider the ballast should consist of brickwork or rubble grouted together, which could be entirely filled up as the work proceeded, thus making a strong and substantial structure. Of course the cheapest method of holding down and ballasting the great tube would be by simply allowing the water to flow into the outer casing, but I consider the former plan by far the best. As regards covering the whole with rubble, or large stones, &c., it would be simply a work of time, and could be proceeded with at leisure, as it would not stop the traffic through the tunnel; huge waggons would be filled on shore and run down the incline on the top of the structure, and by suitable side doors the contents would be discharged immediately over the tube. As regards the ventilation, it would be carried on artificially by having a tube suspended at the top of the tunnel, open at the end, mid-way across, a suction for drawing out the foul air, which would be replaced by air passing into the tunnel. As regards lighting, each train could carry its own "electric light."







Trusting the drawings are sufficiently explanatory, it will give me much pleasure should you grant space in your next issue.

I am, Sir,

Yours truly,

JOHN G. WINTON.

13 Gladstone Street, St. George's Road,
Southwark, *26th August*, 1868.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE MEETING OF THE BRITISH ASSOCIATION AT NORWICH.

Section G.—MECHANICAL SCIENCE.

The President (Mr. Bidder) delivered the opening address. He said the leading object of the Association was the application of science to the great objects of life, and the special object of this committee was to consider the application of the laws of mechanics to all mechanical operations for the benefit of human kind. In mechanics they had this advantage, that the laws they applied were certain, and that their application must be productive of benefit to mankind in general. He proposed on the present occasion to touch upon several topics which were engaging public attention: and first he would deal with the great water question. He congratulated the committee on the presence of several of the most eminent authorities on this question, among whom were Mr. Hawkesley and Mr. Bateman, from whom doubtless the section would be enabled to derive some valuable information before it broke up. The question of the supply of water to towns, and its utilization for manufacturing and other purposes, as well as the requisite means to prevent its pollution by the refuse of manufactories and the sewage of towns, was one of great interest and importance, and might be said to constitute the sensational literature of the profession to which he belonged. Whether they looked at the rivers of India, America, and the continent of Europe, or at those of this country, they would find them all governed by the same general law. It was found that the greatest rainfall took place in high regions, the water finding its way down the sides of the mountains, and forming the rivers which flowed through the valleys below, supplying the towns upon their banks, and affording a valuable means of conveying the products of commerce from place to place. The rainfall in the Himalayas was said to amount to 400 inches per annum; in the mountains of Cumberland the rainfall reached 200 inches per annum, while in the neighbourhood of Norwich the rainfall was only 20 inches per annum. He had been told by the late Robert Stevenson that on one occasion in the Ganges eight inches of rain actually fell within half an hour. The subject was one of so much importance that he thought the Association ought to ask the Government to aid them in making investigations as to the quantities of water falling along the courses of the different rivers; the amount of rainfall at different intervals; and the meteorological phenomena accompanying the different rainfalls. Observations of this kind, taken over a series of years, would furnish a most valuable collection of data for the guidance of engineers. He might illustrate these remarks by a reference to the rivers in this neighbourhood. The Wensum and the Yare converged a little below Norwich; they were joined by the Waveney below Reedham, and by the Bure, which flowed into the harbour at Yarmouth. There was little doubt that there was formerly a great estuary at Yarmouth, but that the water had been confined by the sands which formed the denes along the coast into the narrow channel which flowed through Gorleston. Formerly, he believed, the Waveney flowed through Mutford lock, a dam erected under the advice of some Dutch engineers in order to prevent the incursions of the sea; but however this might be, it was certain that the whole flow of the river between Norwich and Yarmouth was maintained by a fall of between four and five inches. This fact was attended with great advantage to the district; the water did not contain much matter in solution, and the gentle flow of the river maintained a good depth of water for the navigation, and did not destroy the banks, which were composed of a soft material. Such was the facility afforded by the river for navigation, that the wherries plying between Norwich and Yarmouth maintained to this day a wholesome competition with the railway. The waters of the various rivers were subject to laws, about which there could be no doubt until they came into contact with the tide, and here arose an element of discussion which had given rise to much diversity of opinion, and even to some litigation. Yarmouth was surrounded by a vast extent of sand, and the consequence of this was that the tide on both sides, at Aldborough and the Lynn Estuary, rose from 16 to 18 feet at the spring, while it only rose 5 feet at

Yarmouth. The tidal scour at Yarmouth was greatly reduced, and occasioned a large outlay in maintaining the bar and extending the draught of water. But if the tide were as high at Yarmouth as it was on each side, it was doubtful whether it would not produce disastrous results. As to the maintenance of the bar, and how much was due to the rivers and how much to the tide, there was much difference of opinion; and he thought the Association might aid in the elucidation of the question by the collection of accurate data from the authorities at Yarmouth and Lowestoft. He would suggest that as the Association was to meet next in Exeter, similar information should be obtained beforehand by the Association as to the condition of the mouth of the Exe, and the effect of the tides on the different works there. The result of the convergence of the rivers he had mentioned at Yarmouth had been to give that port a monopoly of the trade of the district, and so injurious was this monopoly that forty-three years since the late Sir William Cubitt obtained an Act of Parliament for the construction of a harbour at Lowestoft, the capital for which undertaking was mainly provided from the city of Norwich; but the money subscribed was insufficient to carry out the works on that scale which would enable the harbour to be used to any great extent; and until the railway took it up and made Lowestoft what it now was, the full advantages which Yarmouth could give to the district had never been realized. The Yarmouth people then set about improving their harbour and ameliorating the port-charges, the result of which was that great advantage had been reaped by Norwich and the surrounding districts. There were now two harbours within a few miles of each other constituted on totally different principles—that of Yarmouth being maintained by the flow of water from the land, while that of Lowestoft was maintained partly by dredging, there being no land water, except a little that entered the harbour through the unlocking for vessels. His belief was that the result of a thorough investigation, conducted by competent persons, would show that the land-water gave very little advantage to the port of Yarmouth, and that if the rivers were allowed to pass through to the sea in other directions, a large area of land situated in their neighbourhood, which was now rendered unproductive by the flood and tidal waters, might be utilized. The next topic connected with the water question which he should notice had reference to an undertaking that had excited great attention throughout the world—the Suez Canal, which was now approaching completion, and the success of which would doubtless afford gratification to all right-minded men. That canal passed through what was called the Bitter Lake, which was situated in a depression of the land forty feet below the level of the Red Sea. The lake was dry, and would have to be filled by the waters of the Red Sea, which was distant about eighteen miles. The area of the lake was stated by the French to be 500 million square yards, or about 150 square miles; and as the evaporation of water in Egypt was at the rate of one inch per diem, it would amount over the area of the lake to 3,600,000,000 of cubic feet per diem, or 2500 feet per minute. The water of the Red Sea was depressed by the northerly winds about nine months out of the twelve, and the southerly winds caused the water to rise about five feet. Now, he thought the Association should endeavour to get information as to all the phenomena that might attend the filling of the Bitter Lake. The enormous evaporation of one inch per diem, which was equal to a rainfall of 365 inches per annum, could not but exercise some influence on the atmosphere of the surrounding district, and this ought to be carefully watched, and the most accurate observations taken. The next topic to which he would advert was the state of our navy, some of the departments of which were certainly not in a condition that was altogether satisfactory to the country. He believed the only desire in this country was that we should have the very best ships that were obtainable; but he thought that every one who understood the subject would agree with him that before any vessel was built, her speed and other qualities ought to be determined. This rule ought to be applied to the navy, so that the combined operations of a fleet might be carried out with more certainty than could otherwise be attained. In fact, the speed of all the ships in a fleet ought to be as nearly the same as possible; and this question of speed was highly important, and should be the first consideration, for it would be of little use to arm a vessel with the best guns and the strongest iron plates if she were unable to come within range of a swifter though weaker vessel. The battery of a ship ought to be so placed that the utility of the guns might not be interfered with. Her amount of rolling should be previously ascertained, and he believed that the law regulating the rolling of a vessel could be determined by mathematicians. These things certainly ought to be ascertained before a quarter of a million was expended on a new vessel. He did not think it creditable to the Admiralty or to the constructor of the navy that ships were sent to sea before it was known how much or how little they would roll. With regard to the ability of vessels to go easily through a heavy head-sea, that would depend on the disposition of the weights; and it often happened that this circumstance accounted for a reversal of the relative speed of vessels in smooth and in rough water. In fact, no smooth-water test was sufficient to show the speed of a vessel, and every ship ought to be tested at sea, under the direction of a commission of independent and competent persons. As to the protection to be afforded to a vessel by armour-plating, he thought that this should be made subservient to speed and steadiness; and, with regard to propulsion, he thought that before the country expended a large sum on a new system, as had recently been the case, its utility ought to be ascertained, and it should not be a matter of doubt whether it involved the most economical or the most wasteful application of fuel. With respect to our coast defences, he was one of a corps of volunteers who had been considering this question with a view to advising her Majesty's government thereon, and the first question they had to consider was the defence of East Anglia, the coast of which was undoubtedly the most easily accessible to an enemy of any portion of the kingdom; but, without betraying confidence, he might state that it could, by the adoption of judicious means, be easily defended, and that, too, without the erection of the ponderous forts which had been constructed on the southern coast. The advance in the science of gunnery had almost put an end to the embrasure system, and it was found that men were safer in a line of open country than when crowded into a given point between embrasures, where the fire of powerful artillery could be concentrated upon them. He thought it highly necessary that the whole question of the application of gunpowder to gunnery should be thoroughly considered and absolutely determined. The President next turned to the subject of telegraphy, and having alluded to the Indo-European telegraph, in the completion of which Mr. Siemens was engaged, he expressed a hope that before long this country might obtain an entirely independent line of telegraphic communication with India by way of Gibraltar and the Cape. In conclusion, he referred to technical education, arguing that attention should be chiefly directed to the branch which the student intended to make his pursuit in after life, and that the basis of this education should be a sound knowledge of the laws of mechanics.

ON A PROBABLE CONNECTION BETWEEN THE RESISTANCE OF SHIPS AND THEIR MEAN DEPTH OF IMMERSION. By W. J. Macquorn Rankine, C.E., LL.D., F.R.S.

1. It was pointed out some time ago, that when a wave in water is raised by a floating solid body which is propelled at a speed greater than the natural speed of the wave, the ridge of the wave assumes an oblique position, and the wave advances obliquely; so that while it travels at its own natural speed in a direction perpendicular to its ridge-line, it at the same time accompanies the motion of the solid body at a greater speed. The angle of obliquity of the advance of the wave is such, that its cosine is the ratio of the natural speed of the wave to the speed of the solid body. It was at the same time pointed out, that under these circumstances there is an additional breadth of wave raised in each second, expressed by the product of the speed of the solid body into the sine of the obliquity; or in other words, by the third side of a right-angled triangle, of which the speed of the solid body is the hypothenuse, and the natural speed of the wave the base; that in raising that additional breadth of wave per second, energy is expended; and thus that a rapidly increasing additional term is introduced into the resistance to the motion of the solid body, so soon as its speed exceeds the natural speed of the waves which it raises.

2. The waves taken into account in Mr. Scott Russell's theory of the resistance of ships, are waves whose speed depends on their length alone; and that theory accounts for a rapid increase in the resistance of a ship, when her speed exceeds the natural speed of certain waves of lengths depending on her length.

3. In a paper read to the Royal Society in May, 1868, it was shown that for all waves whatsoever, there is a relation between the natural speed and the virtual depth of uniform disturbance; that is to say, the depth to which an uniform disturbance equal to the disturbance of the surface particles would have to extend, in order to make a total volume of disturbance of the water equal to the actual volume of disturbance. That relation is, that the speed of advance of the wave is that due to a fall of half the virtual depth. In a paper read to the Institution of Naval Architects in 1868, it was pointed out that every ship is probably accompanied by waves whose natural speed depends on the virtual depth to which she disturbs the water; and that consequently, when the speed of the ship exceeds that natural speed, there is probably an additional term in the resistance, depending on such excess.

4. The object of the present paper is to call the attention of the British Association, and especially of the committee on Steam-ship Performance, to the probable existence of this hitherto neglected element in the resistance of ships; and to suggest that suitable observations and calculations should be made in order to discover its amount and its laws. Amongst observations which would be serviceable for that purpose, may be mentioned the measurement of the angles of divergence of the wave-ridges raised by various vessels at given speeds, and the determination of the figures of those ridges, which are well-known to be curved; and amongst results of calculation, the *mean depth of immersion*, as found by dividing the volume of displacement by the area of the plane of flotation; and that not only for the whole ship, but for her fore and after bodies separately, for it is probable that the virtual depth of uniform disturbance, if not equal to the mean depth of immersion, is connected with it by some definite relation.

5. *Results of Observation.*—In an Appendix are given the results of the only three observations which I have hitherto found it practicable to make of the speed of advance of the obliquely diverging waves raised by ships. The waves in each case were those which followed the stern of the vessel; the vessels were all paddle-steamers, but care was taken to observe the positions of the wave-ridges where they were beyond the influence of the paddle-race. The virtual depth corresponding to the speed of advance of those waves is calculated in each case, and it is found to agree very nearly with the mean depth of immersion. It is to be observed, however, that the mean depth of immersion of one vessel only, viz., the *Iona*, has been measured from the plans; for each of the other vessels, a probable value of the mean depth of immersion has been obtained by assuming that it bears the same proportion nearly to the total draught of water in them as in the *Iona*. That assumption cannot be very far from the truth, for the three vessels belong to the same class of forms, being of shallow draught, and very flat-bottomed amidships, but having fine sharp ends.

Few as those observations are, they seem sufficient to prove the existence of waves whose speed of advance depends on the depth to which the vessel disturbs the water. The connection between those waves and the resistance remains as a subject for future investigation.

APPENDIX.

1.—Steam-Vessel "Iona."

Speed of vessel at time of observation, 15 knots = 25·35 feet per second.

Angle made by ridges of stern-waves with course of vessel, 22°; $\frac{1}{2}$ sine of that angle, 0·383.

Product being velocity of advance of stern-waves, 9·71 feet per second.

Virtual depth corresponding to that velocity, $9{\cdot}71^2 \div 32{\cdot}2 = 2{\cdot}93$ feet.

Mean depth of immersion of vessel as measured on her plans, 3·18.

N.B.—The draught of water was 5 feet, so that the mean depth of immersion was 0·64 of the draught nearly.

2.—Granton and Burntisland Ferry Steamer.

Speed of vessel at time of observation, 10 knots = 16·9 feet per second.

Angle made by ridges of stern-waves with course of vessel, 45°; sine of that angle, 0·7071.

Product being velocity of advance of the stern waves, 11 95 feet per second.

Virtual depth corresponding to that velocity, $11{\cdot}95^2 \div 32{\cdot}2 = 4{\cdot}44$ feet.

Draught of water of the vessel, 6·67 feet; probable mean depth of immersion, on the supposition that it is 0·64 draught, 4·3 feet.

3.—Steam-Vessel "Chancellor."

Speed of vessel at time of observation, 12·64 knots = 21·36 feet per second.

Angle made by ridges of stern-waves with course of vessel, 22°; sine of that angle, 0·375.

Product being velocity of advance of the stern-waves, 8·01 feet per second.

Virtual depth corresponding to that velocity, $8{\cdot}01^2 \div 32{\cdot}2 = 2$ feet.

Draught of water of the vessel, 3·5 feet; probable mean depth of immersion, on the supposition that it is 0·64 of the draught, 2·24 feet.

TABLE OF VIRTUAL DEPTHS CORRESPONDING TO DIFFERENT VELOCITIES OF ADVANCE.

Velocity of Advance.			Virtual Depth.	
Knots.	Feet per Second.	Metres per Second.	Feet.	Metres
1	1·69	0·515	0·09	0·27
2	3·38	1·03	0·35	0·108
3	5·06	1·54	0·80	0·243
4	6·75	2·06	1·41	0·433
5	8·44	2·57	2·21	0·676
6	10·13	3·09	3 18	0 973
7	11·8	3·60	4·33	1·325
8	13·5	4·12	5 66	1·73
9	15·2	4·63	7·16	2 19
10	16·9	5·15	8·84	2·70
11	18·6	5 66	10·7	3·27
12	20·3	6·18	12·7	3 89
13	21·9	6·69	14·9	4·57
14	23·6	7·20	17·3	5·30
15	25·3	7·72	19·9	6·08
16	27·0	8·24	22·6	6·92
17	28·7	8·75	25·6	7·81

ON PUDDLING IRON. By C. W. Siemens, F.R.S.

Notwithstanding the recent introduction of cast steel for structural purposes, the production of wrought iron (and puddled steel) by the puddling process ranks among the most important branches of British manufacture, representing an annual production exceeding one and a half million of tons, and a money value of about nine millions sterling.

Notwithstanding its great national importance and the interesting chemical problems involved, the puddling process has received less scientific attention than other processes of more recent origin and inferior importance, owing probably to the mistaken sentiment that a time-honoured practice implies perfect adaptation of the best means to the end, and leaves little scope for improvement.

The scanty scientific literature on the subject will be found in Dr. Percy's important work on iron and steel. Messrs. Crace Calvert and Richard Johnson, of Manchester, have supplied most valuable information by a series of analyses of the contents of a puddling furnace during the different stages of the process.

These prove that the molten pig metal is mixed intimately in the first place with a molten portion of the oxides (or cinder) which forms the lining (or protecting covering) to the cast-iron tray of the puddling chamber, that the silicon is first separated from the iron, that the carbon only leaves the iron during the "boil" or period of ebullition, and that the sulphur and phosphorus separate last of all, while the metal is "coming to nature."

The investigations by Price and Nicholson, and by M. Lari, confirm these results, from which Dr. Percy draws some important general conclusions, which have only to be followed up and supplemented by some additional chemical facts and observations, in order to render the puddling process perfectly intelligible, and to bring into relief the defective manner in which it is at present put into practice, involving, as it does, great loss of metal, waste of fuel and of human labour, and an imperfect separation of the two hurtful ingredients, sulphur and phosphorus.

Silicon.—In forming (by means of the rabble) an intimate mechanical mixture between the fluid cast metal and the cinder, the silicon contained in the iron is brought into intimate contact with metallic oxide; being found afterwards in the form of silicic acid (combined with oxide of iron), it follows that it must have reduced its equivalent of iron from the cinder to the metallic state.

The fluid cinder may be taken to consist of $Fe^3\ O^4$ (this being the fusible combination of peroxide and protoxide), and silicic acid or silica is represented by $Si\ O^3$, from which it may be inferred that for every four atoms of silicon leaving the metal, nine atoms of metallic iron are liberated, and taking the atomic weights of iron = 28, and of silicic acid = 22·5, it follows that for every $4 \times 22{\cdot}5 = 90{\cdot}0$ grains of silicon extracted from the metal, $9 \times 28 = 252$ grains of metallic iron are liberated from the cinder.

Carbon.—The disappearance of the carbon from the metal is accompanied by violent ebullition and the appearance of carbonic oxide, which, in rising in innumerable bubbles to the surface of the bath, burns with the blue flame peculiar to that gas.

It is popularly believed that the oxygen acting upon the carbon of the metal is derived directly from the flame, which should, on that account, be made to contain an excess of oxygen; but the very appearance of the process proves that the combination between the carbon and oxygen does not take place on the surface, but throughout the body of the fluid mass, and must be attributed to reaction of the carbon upon the fluid cinder in separating from it metallic iron.

But it has been argued that, although the reaction takes place below the surface, the oxygen may, nevertheless, be derived from the flame which may oxidize the flame on the surface, and become transferred to the carbon at the bottom, in consequence of the general agitation of the mass.

This view I am, however, in a position to disprove by my recent experience of melting cast steel upon the open flame bed of a furnace, having invariably observed that no oxidation of the unprotected *fluid metal* takes place so long as it contains carbon in however slight a proportion.

Supported by this observation, I feel convinced that the oxidizing action of the flame in a puddling furnace commences only after the malleable iron has been formed already.

Carbonic oxide being represented by C O, and the cinder by $Fe^3\ O^4$, it follows that for every four atoms of carbon, three atoms of metallic iron are liberated; and, taking into account the atomic weights of C 1 = 6 and of Fe = 28, it follows that for every—

$$6 \times 4 = 24 \text{ grains of carbon,}$$
$$28 \times 3 = 84 \text{ grains of metallic iron}$$

is added to the bath.

Assuming ordinary forge pig to contain about 3 per cent. of carbon and the same amount of silicon, it follows from the foregoing that in removing this silicon, $\frac{252}{90} \times 3 = 8{\cdot}4$ per cent., and in removing the carbon $\frac{84}{24} \times 3 = 10{\cdot}5$ per cent. of metallic iron is added to the bath, making a total increase of $8{\cdot}4 + 10{\cdot}5 - 6 = 12\ 9$ per cent.; or a charge of 420 lbs. of forge pig metal, ought to yield 474 lbs. of wrought metal, whereas the actual yield would generally amount to 370 lbs. (or 12 per cent. less than the charge), showing a difference of 104 lbs. between the theoretical and actual yield in each charge.

In order to realize the theoretical result a sufficient amount of cinder must have been supplied, the quantity of which can be readily ascertained. In taking the expression, $Fe^3\ O^4$, the atomic weight of which is $3 \times 28 + 4 \times 8 = 116$, while that of the three atoms of iron alone is $3 \times 28 = 84$. It follows that $\frac{116}{84} \times 54 = 74$ lbs. of cinder is requisite to produce the 54 lbs. of reduced iron.

There must, however, remain a sufficient quantity of fluid cinder in the bath to form with the silicon (extracted from the iron), a tribasic silicate of iron, or about 50 lbs., making in all 166 lbs. of fettling which would have to be added for each charge, a quantity which is generally exceeded in practice, notwithstanding the inferior results universally obtained.

There remains for our consideration the sulphur and phosphorus, which being generally contained in English forge pig in the proportion of from ·2 to ·6 per cent. each, can hardly affect the foregoing quantitative results, although they are of great importance respecting the *quantity* of the metal produced.

It has been asserted by Percy that the separation of these ingredients is due to *liquation.* This I understand to mean that the crystals of metallic iron, which form throughout the boiling mass when the metal "comes to nature," excludes foreign substances in the same way that the ice formed upon sea water excludes the *salt*, and yields sweet water when re-melted.

According to this view, pig metal of inferior quality will really yield iron almost chemically pure, to which foreign ingredients are again added by mechanical admixture with the surrounding cinder, or semi-reduced metal.

It may be safely inferred that the amount of impurities thus taken up will mainly depend upon the *temperature*, which should be high, in order to insure perfect fluidity, or complete separation of the cinder.

The following was the result of an analysis of an inferior English pig iron before and after being puddled:—

Pig Metal.		*Puddled Bar.*	
Iron,	96·079	Iron,	99·276
Sulphur,	·008	Sulphur,	·017
Phosphorus,	1·096	Phosphorus,	·237
Silicon,	1·097	Silicon,	·047
	100·000		100 000

showing the extent to which foreign matters are actually removed by the process of puddling.

These analyses were made a few days since by Mr. A. Willis in my laboratory at Birmingham.

Led by these chemical considerations, and by practical attention to the subject, extending over several years, I am brought to the conclusion that the process of puddling, as practised at present, is extremely wasteful in iron and fuel, immensely laborious, and yielding a metal only imperfectly separated from its impurities.

How nearly we shall be able to approach the results indicated by the chemical reasoning here adopted, I am not prepared to say; but that much can be accomplished by the means actually at our doors is proved by the result of eighteen months' working of a puddling furnace erected to my designs by the Bolton Steel and Ironworks, in Lancashire.

This furnace consists of a puddling chamber of very nearly the ordinary form, which is heated, however. by means of a regenerative gas furnace, the principle of which is sufficiently well established at present to render a special description here unnecessary. The advantages of this furnace for puddling, are that the heat can be raised to an almost unlimited degree; that the flame can be made at will oxidizing, neutral, or reducing without interfering with the temperature; that indraughts of air and cutting flames are avoided and that the gas fuel is free from pyrites and other impurities, which are carried into the puddling chamber from an ordinary grate. In this respect the new furnace presents the same advantages as puddling with charcoal.

The following table gives the working results which were obtained from this furnace, as compared with the results obtained at the same time in an ordinary furnace from the same pig (the ordinary forge mixture).

REGENERATIVE GAS FURNACE.—TABLE No. 1.

First Shift.

Date. 1867.	Nos. of Heat.	Time Charged.	First Ball out.	Metal Charged.	Yield.
				Lbs.	Lbs.
May 27,	1	5·25	6·32	410	392
"	2	6·45	7·50	433	396
"	3	8·8	9·9	430	410
"	4	9·15	10 7	425	426
"	5	10·20	11·22	426	430
"	6	11·40	12·46	412	412
		Second Shift.			
"	1	1·48	2 47	428	410
"	2	2·50	3·47	420	414
"	3	3·56	4·53	426	418
"	4	5·0	6·3	432	417
"	5	6·5	7·12	425	407
"	6	7 20	8·15	420	422
		Third Shift.			
"	1	9·10	10·15	423	414
"	2	10·25	11·30	422	412
"	3	11·35	12 40	420	420
"	4	12 45	2·0	430	410
"	5	2·10	3·10	424	411
"	6	3·16	4·20	420	400
		First Shift.			
May 28,	1	5·38	6·45	423	402
"	2	6·50	8·0	422	400
"	3	8·6	9·8	430	390
"	4	9·15	10·25	426	407
"	5	10·35	11·45	426	420
"	6	11·55	1·8	430	416
		Second Shift.			
"	1	2·0	—	422	422
"	2	3 6	4·0	424	415
"	3	4·5	5·18	423	424
"	4	5 23	6·27	423	415
"	5	6·33	7·46	427	420
"	6	7·49	8·50	420	406
		Third Shift.			
"	1	10·0	11·20	420	424
"	2	11·25	11·33	420	410
"	3	12·40	1·45	423	412
"	4	1·50	2·58	425	420
"	5	3 13	4·20	430	418
"	6	4·30	4·35	422	426

	Cwts.	Qrs.	Lbs.
Total charge,	136	1	2
" yield,	132	3	7
Being at the rate of	20	2	2

of pig iron per ton of puddled bar.

ORDINARY FURNACE.—TABLE No. 2.

Date. 1867.	Time.	Weight of Metal Charged.	Weight of Puddled Bar Produce.
			Lbs.
May 17,	These times were not taken for each charge, but six heats were produced every 12 hours.	Mean 484 lbs.	424
"			425
"			405
"			430
"			430
"			438
"			416
"			410
"			432
"			426
"			420
"			422
"			422
"			425
"			430
"			450
"			410

	Lbs.
Mean charge,	484
" yield,	426

or 22 cwts. 2 qrs. 20 lbs. of pig iron per ton of puddled bar.

It will be observed that the ordinary furnace received charges of 484 lbs. each, and yielded on an average 426 lbs., representing a loss of 12 per cent., whereas the gas furnace received charges averaging 428 lbs., and yielded 413 lbs., representing a loss of 3·5 per cent.

It is important to observe, moreover, that the gas furnace turned out eighteen heats in three shifts per twenty-four hours, instead of only twelve heats per twenty-four hours, which was the limit of production in the ordinary furnace.

The quality of the iron produced from the gas furnace was proved decidedly superior to that from the ordinary furnace, being "*best best*" in the one and "*best*" in the other case from the same pig.

The consumption of fuel was also greatly in favour of the gas furnace, but could not be accurately ascertained, because some mill furnaces were worked from the same set of producers.

The consumption of fettlings was, however, greater in the gas furnace, and the superior yield was naturally attributed by the forge managers to that cause, although the writer held a different opinion.

Finding, however, that the gas furnace had *not* been provided with water bridges, these were subsequently added, and the furnace put to work again in November last, since which time it has been worked continuously.

The result of the water bridges has been that the amount of fettling required is reduced to an ordinary proportion, the average quantity of red ore used being 93·3 lbs. per charge besides the usual allowance of bulldog, while the yield per charge of 475·3 lbs. of gray forge pig has been increased to 476·4 lbs. of puddled bar, as results from the following observations during one turn.

Pig charged.	Puddled bar returned.
Lbs.	Lbs.
470	470
480	482
486	460
468	470
470	500
478	476
Mean result, 475·3	476·4

proving an average gain of fully 12 per cent. over the yields of ordinary furnaces, while the superiority of quality in favour of the gas furnace is fully maintained.

It is also worthy of remark that these results are obtained regularly by the ordinary puddlers of the works, and that no repairs have been necessary to the gas puddling furnace since November last, the roof being reported to be still in excellent condition.

In these investigations I have confined myself to the puddling of ordinary English forge pig in order to avoid confusion; but it is self-evident that the same reasoning also applies in a modified degree to white pig metal or refined metal, the use of which I should not, however, advocate.

Water Bridges.—Regarding the water bridges, I was desirous to ascertain the expenditure of heat at which the saving of fettling and greater ease of working was effected. The water passing through the bridges was accordingly measured by Mr. W. Hackney (who has also furnished me with the other working data) and found to amount to 25 lbs. per minute, heated 40° Fahr. This represents 60,000 units of heat per hour, or a consumption not exceeding 8 lbs. to 10 lbs. of solid fuel per hour, an expenditure very much exceeded by the advantages obtained where water or cooling cisterns are available.

The labour of the puddler and of his underhand being very much shortened and facilitated by means of the furnace, I should strongly recommend the introduction of three working shifts of 8 hours each for 24 hours, each shift representing the usual number of heats, by which arrangement both the employer and the employed would be materially benefited. The labour of the puddler may be further reduced with advantage by the introduction of the mechanical rabble, which has already made considerable progress on the Continent.

By working in this manner a regenerative gas puddling furnace of ordinary dimensions would produce an annual yield of about 940 tons of bar iron of superior quality from the same weight of gray pig metal and the ordinary proportion of fettling.

In conclusion, I may state that a considerable number of these puddling furnaces have been erected by me abroad, and that in this country they are also being taken up by Messrs. Kitson of Leeds, and a few other enterprising firms.

ON THE RECENT PROGRESS OF STEEL MANUFACTURE.

By Ferdinand Kohn, C.E.

At the last meeting of the British Association in Dundee, I had the honour to draw the attention of this section upon a new mode of steel manufacture which at that time had commenced to gain ground on the Continent, but which had not been brought into commercial practice in any one of the numerous steelworks of this country.

I refer to the process of manufacturing steel upon the open hearth of a Siemens furnace by the mutual reaction of pig iron and decarburized iron, or "wrought iron," upon each other—a process which in France has received the name "Martin process," from its inventors, Messrs. Emile and Pierre Martin, of Paris, but which, in justice to both the inventors to whom the practical and commercial success of this innovation is due, should bear the name "Siemens-Martin process." Within this last year the Siemens-Martin process has been brought into operation in this country, and I have now the pleasure to lay before this meeting a few samples of steel which have been made by that new process in the Cleveland district, and, in a very considerable proportion, from Cleveland iron.

I hope, therefore, that it will not be out of place to give to this section a brief account of the technical detail of this new mode of steel manufacture, and to make a few remarks upon its commercial prospects, so far as the latter can be judged at present.

The Siemens-Martin process realizes the old and repeatedly proposed idea of melting wrought iron in a bath of liquid pig iron, and thereby converting the whole mass into steel. The principal elements of its successful operation, and the points which distinguish it from all previous abortive attempts, are—first, the high temperature and the neutral or non-oxidizing flame produced by the regenerative gas furnace of Mr. Siemens; and secondly, the method of charging the decarburized iron into the bath of pig iron in measured quantities or doses.

These doses of wrought iron or steel are added to the bath in regular intervals, so that each following charge in melting or in being dissolved in the bath increases the quantity of the liquid mass, and adds to the dissolving power of the bath until the stage of complete decarburization is arrived at. The charge is then completed by adding to the decarburized mass a certain percentage of pig iron, or of the well-known alloys of iron and manganese, such as spiegeleisen or ferro-manganese, and the degree of hardness or temper of the steel produced depends on the proportion of this final addition.

The process as characterized above has been experimented with at the Model Steelworks, in Birmingham, by Mr. Siemens, and on a larger scale at the Bolton Steelworks. From this latter establishment a railway tyre made from Bessemer steel scrap and pig iron upon the open hearth of a Siemens furnace has been sent for exhibition to this meeting. The first and, as yet, the only steelworks in this country which is working this process commercially, and which is laid out for the manufacture of steel by the Siemens-Martin process exclusively, are the Newport Steelworks, at Middlesbro'-on-Tees, belonging to the well-known firm of Messrs. B. Samuelson & Co.

The Newport Steelworks commenced operations about two months ago, and have been working since that time with great regularity, and almost without interruption, day and night. There is one steel-melting furnace constructed from the designs of Mr. C. W. Siemens in operation at present, and a second similar furnace is to be erected very shortly.

The roof of the furnace is made of Dinas brick, and the bed upon which the charges are melted is made of ganister or pure silicious sand mixed with a red sand containing a small per centage of alumina, both kinds of sand being found in the Cleveland district. The preparation of the furnace bottom requires great care, and a certain amount of skill on the part of the workmen. All materials charged into the furnace are previously heated to redness in an auxiliary heating furnace. The pig iron employed for forming the bath is principally Swedish charcoal pig iron, and it enters into the charges in the proportion of about one-third of the total weight. The tables annexed to this paper, which are copies of the records of some interesting charges kindly placed at my disposal by Messrs. Samuelson and Co., give a clear idea of the precise mode of conducting the charge. Table No. 1 is the record of a charge made of Swedish pig iron (1680 lbs.), and of puddled bars from Cleveland iron (3136 lbs.). A small quantity of hæmatite ironstone was added to the charge during the operation, with the intention to reduce the time required for the process, which occupied thirteen hours; but from the large proportion of spiegeleisen (1560 lbs.) required at the end, it appears that decarburization had been carried too far, and the charge could have been completed several hours earlier. At the same time this example shows the great facility which the Siemens-Martin process affords with regard to the correction of errors committed in conducting a charge. The production of any desired temper of steel can be relied on with absolute certainty, since the ultimate success is a mere question of time, and it is of comparatively little consequence how far the desired charge of decarburization may have been overstepped or neglected during the operation, if the final addition brings the charge back to its proper temper and quality.

Table I.

No. *Furnace.* *Monday night, July* 20, 1868.

Times of Charging.	Charges.				Make.	
	Swed. Pig Iron.	K. & J. Pud. Bars.	Hæmatite Ironstone.	Spiegeleisen.	Ingot Steel.	Scrap Steel.
O'clock.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
8.0	1680	—	—	—	—	—
9.40	—	224	—	—	—	—
10.0	—	224	—	—	—	—
10.30	—	224	—	—	—	—
11.0	—	224	—	—	—	—
11.45	—	224	15	—	—	—
12.30	—	224	15	—	—	—
1.0	—	224	15	—	—	—
1.40	—	224	15	—	—	—
2.40	—	224	—	—	—	—
3.20	—	224	—	—	—	—
4.0	—	224	15	—	—	—
4.40	—	224	—	—	—	—
5.30	—	224	15	—	—	—
6.10	—	224	—	—	—	—
7.15	—	—	—	224	—	—
8.5	—	—	—	112	—	—
8.45	—	—	—	224	—	—
9.0	—	—	Soft	steel,	4962	116
5466 lbs.	1680	3136	90	560	4962	116
Cwts. Lbs. Oz. 48 3 6	Cwts. 15	Cwts. 28	Lbs. Oz. 3 6	Cwts. 5	Cwts. Lbs. Oz. 44 1 6	Cwts. Lbs. Oz. 1 0 4

Loss, ... 7·10 *per cent.*

Table No. 2 is a record of an attempt to use Cleveland pig iron for the bath.

Table II.

No. *Furnace.* *Thursday, July* 30, 1868.

Times of Charging.	Charges.					Make.
	Cleveland Gray Pig Iron.	K. & J. Pud. Bars.	K. & J. Patent Slag.	Ilmenite.	Spiegeleisen	Scrap Steel.
O'clock.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
5.0	2240	—	—	—	—	—
6.30	—	—	280	—	—	—
7.5	—	—	280	—	—	—
8.5	—	224	—	—	—	—
8.35	—	224	—	—	—	—
9.5	—	224	—	—	—	—
9.30	—	224	—	—	—	—
10.0	—	224	—	—	—	—
10.30	—	224	—	—	—	—
11.5	—	224	—	—	—	—
11.45	—	224	—	—	—	—
12.20	—	224	—	—	—	—
12.55	—	224	—	—	—	—
1.30	—	224	—	—	—	—
2.0	—	224	—	35	—	—
2.30	—	224	—	35	—	—
3.0	—	224	—	35	—	—
3.30	—	—	—	35	—	—
4.0	—	—	—	35	—	—
4.25	—	—	—	35	—	—
6.15	—	—	—	—	448	—
7.0	—	—	—	—	—	5446
6594 lbs.	2240	3136	560	210	448	5446
Cwts. Lbs. Oz. 58 3 14	Cwts. 20	Cwts. 28	Cwts. 5	Cwts. Lbs. Oz 1 3 14	Cwts. 4	Cwts. Lbs. Oz. 48 2 14

Remarks: Cold-short, brittle (not to be smelted in steel furnace). *Loss*, 17·41 *per cent.*

The puddled bars added to the charge were of the same kind as those used with the Swedish pig iron, and the addition of Ilmenite, a mineral containing a high percentage of titanium—was made with a hope to remove phosphorus from the bath. With a similar idea a quantity of so-called patent slag—a mixture of ingredients to which a similar power is ascribed in the Cleveland district—has been added, but without success. The product was found cold-short and brittle, and the Cleveland pig iron has thereby been proved unsuitable for the Siemens-Martin process.

Table No. 3 records a charge made with gray hematite pig iron and Cleveland puddled iron. The product is a steel of less ductility and malleability than that

Table III.

No. *Furnace.* *Tuesday, August* 4, 1868.

Times of Charging.	Charges.					Make.	
	Millom. Hæmatite Gray Pig Iron.	K. and J. Billets Pud. Bars.	Hæmatite Ironstone.	Ilmenite.	Spiegeleisen.	Ingot Steel.	Scrap Steel.
O'clock.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
9.5	1344	—	—	—	448	—	—
10.45	—	224	—	—	—	—	—
11.0	—	224	—	56	—	—	—
11.30	—	224	—	—	—	—	—
11.50	—	224	—	56	—	—	—
12.15	—	224	—	—	—	—	—
1.0	—	224	—	—	—	—	—
1.45	—	224	—	—	—	—	—
2.15	—	224	—	—	—	—	—
3.20	—	224	56	—	—	—	—
4.45	—	224	56	—	—	—	—
6.0	—	224	—	—	—	—	—
6.45	—	224	—	—	—	—	—
7.20	—	224	—	—	—	—	—
7.45	—	—	—	—	224	—	—
8.20	—	—	—	—	224	—	—
9.0	—	—	—	—	—	4536	124
5376 lbs.	1344	2912	112	112	896	4536	124
48 cwts.	12 cwts.	26 cwts.	1 cwt.	1 cwt.	8 cwts.	40c. 2lbs.	1c. 12lbs.

derived from Swedish pig iron. There is also an excessive loss, amounting to 17 04 per cent. of the total weight charged into the furnace shown by this table. This seems to indicate a high percentage of silicon in the pig iron, to the partial and imperfect removal of which both the hardness of the steel and the great waste may be due. It is not possible, however, from this single experiment to draw a reliable conclusion with regard to this class of pig iron.

Tables No. 4 and 5 show some of the most successful charges made at Messrs. Samuelson and Co.'s works. From these charges the samples which I have exhibited here are taken. The bath of pig iron in these charges is made of a mixture of white Swedish iron and of spiegeleisen; besides this, a quantity of spiegeleisen is added at the end of the operation. In these charges Cleveland bars enter in the proportion of about one-half. The steel produced in this manner is very soft and of a very fine quality; it is principally used for boiler plates and for similar articles. Some tests with regard to the strength and elasticity of this steel are now in progress at Mr. Kirkaldy's testing works, but the results have not reached me as yet.

TABLE IV.

Remarks: Rails. *Loss:* 17·02 *per cent.*

No. Furnace. *Wednesday, August* 5, 1868.

Times of Charging.	Charges.				Make.	
	Swed. Pig Iron.	K. & J. Scrap Pud. Bars.	Hæmatite Iron-stone.	Spiegel-eisen.	Ingot Steel.	Scrap Steel.
O'clock.	Lbs.	Lbs	Lbs.	Lbs.	Lbs	Lbs
5.15	1680	—	—	1008	—	—
7.10	—	448	—	—	—	—
7.50	—	448	—	—	—	—
8.30	—	448	—	—	—	—
9.5	—	448	—	—	—	—
9.50	—	448	—	—	—	—
10.35	—	448	—	—	—	—
11.15	—	448	—	—	—	—
12 5	—	448	—	—	—	—
12.55	—	448	—	—	—	—
1 55	—	448	—	—	—	—
2.30	—	448	—	—	—	—
3.20	—	448	—	—	—	—
4.10	—	224	28	—	—	—
4.40	—	224	28	—	—	—
5.15	—	224	28	—	—	—
5.50	—	224	28	—	—	—
6.35	—	224		—	—	—
7 10	—	224	—	244	—	—
7.50	—	—	—	—	—	—
8.30	—	—	Soft	steel, . .	8624	304
9764 lbs.	1680	6720	112	1252	8624	304
Cwts. Lbs. Ozs. 87 0 20	Cwts. 15	Cwts 60	Cwts. 1	Cwts. Lbs. Ozs. 11 0 20	Cwts. 77	Cwts. Lbs. Ozs. 2 2 24

Remarks: Very soft. *Loss*, 8 50 *per cent.*

The quantity of fuel used in this process of steel melting, including the fuel for the auxiliary heating furnaces, is about one ton of coal per ton of steel produced.

From the above data the question of prime cost may be answered approximately.

TABLE V.

No. 1 *Furnace.* *Wednesday night, August* 5, 1868.

Times of Charging.	Charges.					Make.	
	Swedish Pig Iron.	K. and J. Pud. Bars.	Scrap Steel.	Hæmatite Iron-stone.	Spiegel-eisen.	Ingot Steel.	Scrap Steel.
O'clock.	Lbs.	Lbs.	Lbs	Lbs.	Lbs.	Lbs.	Lbs.
12 0	1680	—	—	—	560	—	—
1.35	—	—	224	—	—	—	—
2.0	—	—	224	—	—	—	—
2.30	—	418	—	—	—	—	—
3.5	—	448	—	—	—	—	—
3 40	—	448	—	—	—	—	—
4.15	—	448	—	—	—	—	—
4.50	—	448	—	—	—	—	—
5.25	—	448	—	—	—	—	—
6.5	—	448	—	—	—	—	—
6.45	—	448	—	—	—	—	—
7.30	—	448	—	—	—	—	—
8.30	—	418	—	28	—	—	—
9.25	—	448	—	28	—	—	—
10.45	—	224	—	—	—	—	—
11.15	—	—	—	—	224	—	—
12.0	—	—	—	Soft	steel,	6972	148

Remarks: Very soft. *Loss*, 12·32 *per cent.*

Taking the price of Swedish pig iron and of spiegeleisen at £6 per ton, that of Cleveland bars at £5, and the average waste in the furnace at 10 per cent., we require for 1 ton of steel ingots:*—

	£	s.
11 cwts. of pig iron at £6, ...	3	6
11 cwts. of puddled bars at £5, ...	2	15
1 ton of coal, ...		5
Cost of materials, ...	6	6

The expenses for wages, repairs of plant, and royalties to both the patentees, will bring the prime cost of the Siemens-Martin steel ingots to about £7 10*s.* per ton, which is precisely the same as the prime cost of Bessemer steel ingots made from hematite pig iron in this country.

The Siemens-Martin process seems to have a vast importance for the ironmasters of many localities. It is applicable to the conversion of old materials (wrought iron and steel), it can utilize the waste and offal of all other processes of steel manufacture, it is not limited to gray or highly carburized pig iron, and it can for all these reasons be introduced into localities which have hitherto been in an unfavourable position for the production of steel. The question naturally arises how this new process will affect the progress of the Bessemer process, of which it seems to be a rival. In my opinion the only influence which the Siemens-Martin process can have upon the Bessemer steel trade will be to stimulate and assist the latter, and to widen the sphere of its application. The two processes, working with two different classes of raw materials, can never come into direct rivalry. Wherever gray pig iron can be had of sufficient purity for direct conversion the Bessemer process will be the most advantageous, and, indeed, the only suitable mode of steel manufacture;† but in all cases where the raw material is wrought iron, white pig iron, or pig iron which must be freed from its impurities by puddling before it can serve as a material for steel manufacture, the Siemens-Martin process will find its place. By working up the waste and offal of the Bessemer steelworks, the crop ends of steel rails, and similar material, the new process will assist in cheapening the prime cost of Bessemer steel, in which the waste plays an important part.

The Siemens-Martin process, although it is not capable of employing the inferior kinds of pig iron for the manufacture of steel direct, is a process of steel manufacture applicable to the inferior classes of iron. It seems destined, therefore, to render a most important service to all those great centres of an old established iron manufacture, the future existence of which have been endangered by the irresistible competition of the Bessemer process, which itself was inapplicable to the raw materials available in those localities.

The new process will, therefore, render another important service to the Bessemer process, and to steel manufacture in general, by introducing steel manufacture into localities which have been hitherto debarred from it by unfavourable natural conditions. This will, to a great extent, destroy the great and organized opposition which has been raised against the general introduction of steel instead of iron for engineering purposes, and will thereby remove one of the most powerful drawbacks now hampering the spread and progress of steel manufacture in this country.

ON THE RELATION OF FOOD TO WORK DONE BY THE BODY; AND ITS BEARING UPON MEDICAL PRACTICE.

By the REV. S. HAUGHTON.

Preliminary note.

WE have been favoured by the distinguished author of the following inaugural address, delivered recently before the University of Oxford upon occasion of his receiving the honorary degree of LL.D., with proofs, as yet unpublished. We are therefore enabled to lay some condensed extracts before our readers, which will not be devoid of interest to all who care to find lucid and new statements on the important and difficult subject of the relation between the fuel and the work in that most wonderful of all machines—the animal.

Introductory.

Man, like other animals, is born, grows, comes to maturity, reproduces his like, and dies; passing in his lifetime through a cycle of changes that may be compared to a *secular* variation, by a metaphor borrowed from the science of astronomy; while in his daily life he passes through a smaller cycle of changes that may be called *periodic.*

From the time of the publication of Bichat's "Essay on Life and Death," it has been admitted that man and other animals possess a double life, *animal* and *organic*, presided over respectively by two distinct, though correlated centres of nervous force: of these, one *thinks*, *moves*, and *feels;* the other merely *cooks;* receiving the food supplied, changing and elaborating it into elements suitable for the use of the animal life.

In the lower forms of animals the organic life becomes almost coextensive with the whole being of the creature, which simply digests, assimilates, and excretes, but barely feels or moves. In the higher forms of animals, and more especially in man, the animal life dominates over the organic life, which becomes its slave, and it exhibits the remarkable phenomena of *mechanical force*, of *geometrical instinct*, of *animal cunning*, and finally, in man himself, produces *intellectual work*, rising to its highest form in the *religious feeling* that recognizes its great Creator, and bows in humility before him.

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* We deem the prices set down for Swedish white pig and spiegeleisen, as well as the percentage of waste, as sensibly too low.—ED.

† This admits of being already strongly contested, and, indeed, is pretty certain very shortly to show itself to be far too sweeping an assertion.—ED.

It is a simple matter of fact, and of every day observation, that all these forms of *animal work* are the result of the reception and assimilation of a few cubic feet of oxygen, a few ounces of water, of starch, of fat, and of flesh.

The general question of the relation of Food to Work would involve a consideration of the possibility of throwing a bridge across the gulf that separates the organic from the animal life, so as to connect the products of nutrition (taken in its widest sense) with the work of every kind accomplished by the animal life, whether mechanical or intellectual.

We resemble the spiders of the heather on a summer morning, that float their gossamer threads into the air from the summit of a branch, in the hope that some stray breath of wind may fasten it to a neighbouring tuft, and enable the hungry speculator to extend the range of his rambles and his chance for food. Already a few feeble threads connect the chemistry of our food with the *mechanical work* done by our muscles; when these have been securely fastened, from the higher vantage ground acquired, our little bridge of knowledge may possibly be extended to embrace the phenomena of the geometrical instinct of the bee, or the cunning of the beaver: and our successors may even dare to speculate on the changes that converted a crust of bread, or a bottle of wine, in the brain of Swift, Molière, or Shakespeare, into the conception of the gentle Glumdalclitch, the rascally Sganarelle, or the immortal Falstaff.

At present such thoughts would be justly regarded as the dreams of a lunatic, and I must crave your indulgence for having mentioned them. The history of science is, however, filled with such dreams: some never realized; others converted by time into realities so commonplace, that the genius of their originators is habitually forgotten or underrated.

During childhood and youth the food that we eat is used for the double purpose of building up the tissues of the bones, the muscles, the brain, and other organs of the body, and of supplying the force necessary for work done, whether mechanical or intellectual. In adult life the first use of food almost disappears, for the bones, the muscles, the brain, and other organs, have already reached their full development, and act simply as the media of communication between the food received and the work developed by it.

Let us take, as illustrations, the muscles and brain, regarded as the organs by means of which mechanical and intellectual work is done. These organs resemble the piston, the beam, and the fly-wheel of the steam engine, and, like them, only transmit or store up the force communicated by the steam in one case, and by the products of the food conveyed by the blood in the other case. The mechanical work done by the steam engine must be measured by the loss of heat experienced by the steam in passing from the boiler, through the cylinder, to the condenser; and not by the loss of substance undergone by the several parts of the machinery on which it acts. In like manner, the mechanical or intellectual work done by the food we eat is to be measured, not by the change of substance of the muscles or brain employed as the agents of that work, but simply by the changes in the blood that supplies these organs—that is to say, undergone by the food used, in its passage through the various tissues of the body, before it is finally discharged in the form of water, carbonic acid, or urea.

The Divine Architect has so framed the animal machine that moves and thinks, that the same blood, which by its chemical changes produces movement and thought, also repairs the necessary waste of the muscles and brain, by means of which movement and thought are possible; just as if the steam that works an engine were able, without the aid of the engineer, to repair the wear and tear of its friction and waste spontaneously; but no greater mistake is possible in physiology than to suppose that the products of the changes in the blood, by which mechanical or intellectual work is done, are themselves merely the result of the waste of the organs, whether muscles or brain, on the exercise of which that work depends.

The ancients, who derived all their knowledge from observation, and not from experiment, were well aware of the double duty imposed upon food in early life—of producing both the *secular* and the *periodic* variations of the body; or, in other words, of promoting growth and of developing work.

Their practical knowledge is summed up by Hippocrates in the aphorism—

"Old men bear want of food best; next those that are adults; youths bear it least, more especially children; and, of these, the most lively are the least capable of enduring it."

The food consumed in twenty-four hours, including air and water, undergoes a series of changes of a chemical character before leaving the body, in the form of one or other of its excretions. Some of these changes develop force, and others expend force, but the algebraic sum of all the gains and losses of force represents the quantity available for work. This work must be expended as follows:—

1. The work of growth (*secular*).
2. The work of maintaining heat (*periodic*).
3. Mechanical work (*periodic*).
4. Vital work (*periodic*).

Hippocratic Doctrine of Innate Heat.

Hippocrates was well aware of the connection between food and animal heat, although he erroneously regarded the animal heat as an innate property of the body that caused an appetite for food, instead of being itself produced by food: if we transpose his cause and effect, *mutatis mutandis*, all his maxims as to animal heat are true. Thus, he says—

"Growing animals possess most innate heat, hence they require most food; . . . . but the old have least heat, and therefore require the least fuel."

"The cavities of the body are naturally warmest in winter and spring; . . . in these seasons, therefore, most food must be given; and since there is more innate heat, more nourishment is required; as may be seen in youths and athletes."

These maxims, when translated into modern language, express the well-known fact, that the chemical changes of food that take place in the body produce animal heat, and that the necessity for food to supply mechanical work is greatest with the young and active, while the necessity for the production of animal heat is greatest in the cold seasons of the year.

Lavoisier's Theory of Animal Heat.

The doctrine of "innate" heat, taught by Hippocrates and Galen, ruled in medicine for 1500 years after Galen's death; until it received its death blow from the genius of Lavoisier, who demonstrated in his celebrated memoir read before the French Academy of Sciences in 1783, that the source of animal heat is to be found in the combustion of the carbon of the body by the oxygen of the air received into the lungs by respiration. Lavoisier's experiments were repeated and confirmed in 1822 by Dulong and Despretz; and have formed the starting point for all modern investigations on the relation of food to work.

Lavoisier arranged his experiments so as to exclude almost all kinds of work done, except that of animal heat. A guinea-pig was placed under a bell-glass inverted over a surface of mercury, and a current of fresh air was allowed to circulate through the apparatus, being passed at its final exit through tubes containing caustic potash, which arrested the carbonic acid produced by the animal. In this manner it was easy to ascertain the carbonic acid excreted, by the increase in weight of the tubes of caustic potash during the experiment.

Lavoisier found that his guinea-pig, in ten hours, burned, on the average, 3·333 grms. of carbon; and this quantity of carbon he estimated from other experiments as capable of melting 326·75 grms. of ice at the freezing temperature.

The same guinea-pig was then placed in an ice calorimeter, and left in it for ten hours, during which time the heat of its body was found to have melted 402·27 grms. of ice at the freezing temperature.

If we use, instead of the coefficient of combustion of carbon employed by Lavoisier, that now generally adopted from the experiments of Favre and Silbermann, the quantity of melted ice represented by $3\frac{1}{3}$ grms. of carbon would become 364·78 grms., instead of 326·75 grms.

We are, therefore, entitled to say that the heat of combustion of expired carbon determined by Lavoisier is equal to

$$\frac{36478}{402{\cdot}27} = 90{\cdot}68 \text{ per cent.}$$

of the animal heat developed, which is regarded as 100.

Two years later, in 1785, Lavoisier laid before the Royal Society of Medicine of Paris an account of further experiments, also conducted on the breathing of guinea-pigs, by which he showed, that of 100 parts of oxygen absorbed by those animals, 81 only reappeared in the form of carbonic acid, and 19 parts disappeared altogether. Lavoisier considered that these 19 parts of oxygen were employed in the body in the combustion of hydrogen, the product of such combustion being water.

If we use Lavoisier's data just given, and the known atomic weights of carbon, oxygen, and hydrogen, we shall have, for 81 parts of oxygen in the form of carbonic acid, and 19 parts of oxygen in the form of water, the following quantities of carbon and hydrogen consumed by the respiration of a guinea-pig in the same time:—

$$\text{Carbon} = \frac{6 \times 81}{16}$$

$$\text{Hydrogen} = \frac{19}{8}$$

Multiplying these numbers by the heat coefficients of Favre and Silbermann, we find—

$$\text{Heat produced by carbon} = \frac{6 \times 81}{16} \times 8080$$

$$\text{Heat produced by hydrogen} = \frac{19}{8} \times 34462$$

It has been already shown that the heat developed by the combustion of carbon in Lavoisier's experiment amounted to 90·68 per cent. of the heat emitted by the animal; hence the heat produced by the combustion of the hydrogen will amount to

$$90{\cdot}68 \times \frac{19 \times 34462}{8} \times \frac{16}{6 \times 81 \times 8080}$$

= 30·24 per cent. of the heat emitted by the animal. By adding together the heats due to the carbon and hydrogen, we find that Lavoisier's experiments, when fairly interpreted by the data of modern science, give the following results:—

Heat produced by the combustion of carbon and hydrogen, .	120·92
Animal heat, ...	100·00

Finally, in 1789, Lavoisier published further experiments, by which he showed conclusively that the consumption of oxygen by the body is notably increased by three causes—

1. By a lowering of the external temperature.
2. By the act of digestion.
3. By muscular exercise.

The experiments of Lavoisier were repeated in 1822 by Dulong and Despretz, and their results, when corrected, like those of Lavoisier, by using the modern heat coefficients of carbon and hydrogen, are as follows:—

The mean of Dulong's experiments on sixteen animals and birds is 90·6 per cent. of the animal heat given out—the lowest number, 85·5, belonging to a kitten sixty days old; and the highest number, 99·4, belonging to a puppy fifty days old.

M. Despretz obtained an average of 92·3 from sixteen mammals and birds—his highest number being 101·8, derived from an old female rabbit; and his lowest number being 84·2, derived from four owls.

The foregoing experiments left no doubt remaining in the minds of men of science as to the substantial truth of Lavoisier's doctrine of animal heat; and led immediately to a number of supplementary experiments, amongst the most remarkable of which were those of Regnault and Reiset.

Regnault directed his attention especially to the distribution of the oxygen absorbed by animals, between the carbon and hydrogen of their blood, or tissues, which had been laid down by Lavoisier in the proportion of 81 to 19. He found that the proportion was not a fixed one, but varied with the food in a very instructive manner.

The average of his experiments on fourteen animals, including worms, lizards, and insects, as well as birds and mammals, was—

Oxygen combined with carbon, ...	81·7
Oxygen combined with hydrogen, ...	19·3

a result identical with that found by Lavoisier. The highest proportion of oxygen combined with hydrogen occurred in the case of chickens fed on meat, and amounted to 32 per cent.; and the lowest proportion occurred in the case of rabbits fed on bread and oats, and amounted to 1 per cent. only.

Still more recent experiments, made with improved apparatus and methods by Pettenkofer and Voit, in Munich, show, like those of Regnault, that the proportion of the oxygen employed in forming carbonic acid, to the whole oxygen absorbed, varies with the food, ranging in the case of a large dog from 52·4 to 148·2, according as the animal was kept altogether without food or fed upon a mixed diet of meat and sugar. These investigations have also shown that under ordinary conditions it is probable that a dog consumes nearly all the oxygen absorbed in the formation of carbonic acid.

Before leaving the subject of animal heat, it is worth while to estimate its amount in a manner that will bring it into comparison with ordinary mechanical work.

In Lavoisier's experiment with the guinea-pig, 402·27 grms. of ice were melted in ten hours; from this fact we find, assuming the latent heat of ice at 142° F., and 772 as Joule's coefficient for converting British heat units into foot pounds,

Mechanical work equivalent to the daily animal heat of Lavoisier's guinea-pig =

$$\frac{402{\cdot}27 \times 24 \times 142 \times 15\,432 \times 772}{7000 \times 10}$$

$$= 233310 \text{ foot pounds.}$$

As the average weight of a guinea-pig is 4 lbs., the preceding amount of work, representing animal heat, would be sufficient to raise the weight of the animal through a vertical height of

$$\frac{23310}{4 \times 5280} = 11{\cdot}05 \text{ miles.}$$

Ranke has shown, by experiments made upon himself, under various conditions of food and fasting, by means of Pettenkofer and Voit's apparatus, that his daily excretion of carbonic acid varied from 660 grms. to 860 grms. His weight was 67 kilos., from which fact, and the assumption that an English mile is 1600 metres, we obtain, employing the contents already given, the height through which the combustion of this quantity of carbon would raise the weight of 67 kilos. in 24 hours—

$$= \frac{760 \times 6 \times 8{\cdot}080 \times 423}{22 \times 67 \times 1600} = 6{\cdot}609 \text{ miles.}$$

The extreme values of the carbonic acid excreted, viz., 660 grms. and 860 grms., would correspond to the heights of 5·74 miles and 7·48 miles respectively.

Pettenkofer and Voit succeeded in producing a range of carbonic acid excreted by a large dog, weighing 33·3 kilos., from 289·4 grms. to 840 4 grms; the minimum corresponding to the tenth day of fasting from solid food, and the maximum corresponding to a diet of 1800 grms. of meat, 350 grms. of fat, and 1410 grms. of water.

It may be easily shown by a calculation similar to the foregoing, that these excretions of carbonic acid correspond to the mechanical works of lifting the weight of the dog through vertical heights of 5·03 miles and 14·62 miles respectively.

Combining together the preceding results, and expressing them all in the natural units of the weights of the animals lifted through a height, we find—

Work due to Animal Heat.

1. Guinea-pig.	11·05 miles.
2. Man, ...	5·74 "
3. Man, ...	7·48 "
4. Dog, ...	5·03 "
5. Dog, ...	14·62 "
Mean, ...	8 784

Source of Muscular Work.

As soon as it was satisfactorily established by Lavoisier and his successors that the natural combustion of carbon and hydrogen in the blood was sufficient, and rather more than sufficient, to account for the animal heat, it became a matter of great interest to physiologists to ascertain, if possible, how much of the work developed in the blood by chemical changes is employed in producing animal heat, how much in mechanical work, external and internal, and how much in vital or mental operations.

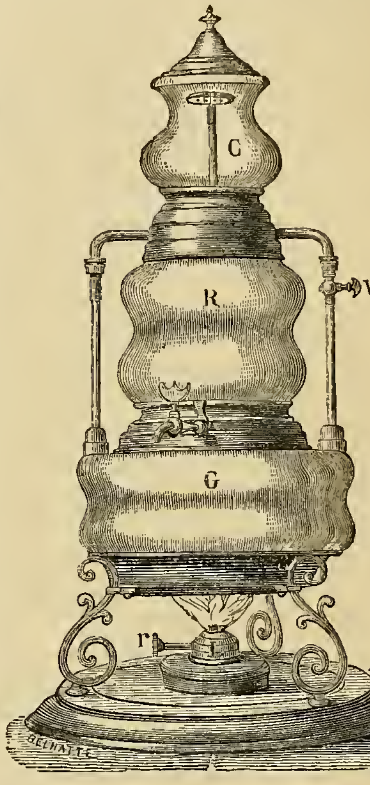
At the outset of this inquiry it received a misdirection from the conjecture thrown out by Liebig, that the excretion of nitrogen (in the form of urea) gave necessarily the measure of the wear and tear of the muscular tissues themselves, which are composed of proteinic or nitrogenous compounds. This conjecture led to Liebig's celebrated classification of food into *heat-producing* and *flesh-forming* foods, which has been unhesitatingly received until lately, in this country, by physiologists and physicians.

Opposite theory of Traube.

(*To be continued.*)

MONTHLY NOTES.

The "Favourite" Coffee Machine.—It has often been said that a good coffee-pot is a real treasure, and it seems in this case that the inventor has based his new machine on principles rational in theory, whilst they are at the same time ingeniously carried out in practice. The effects of coffee on the human system varying according to its preparation, the true amateur is always known by his choice of a coffee machine. To obtain an aromatic beverage, light and well perfumed, he will take care to pass the water only once, thus leaving the bitter and indigestible salts, containing an excess of alkaline matter, in order not to weaken or fatigue the stomach and, consequently, general health. With this apparatus, by one filtration, a clear palatable infusion is obtained, and it is easy, by raising the cover, to perceive the nauseous and bitter taste of the dregs which would spoil the first operation of the machine, if the water were allowed to pass through twice. In using this apparatus water is first introduced into the generator, G, see engraving, by the opening opposite the cock, in sufficient quantity to cause the submerged tube to just dip into it. Then must be added the quantity of water necessary for the number of cups required, bearing in mind that the ground coffee absorbs a small portion. The spirit lamp, I, is then lighted, but not to its full extent, and the steam cock, V, is opened; if this be forgotten, the only effect will be the mounting of the water, produced by the pressure of the steam, which generally commences to act at 122° Fahr., and it is easily seen. The coffee is then deposited on the filter in C, and the cover is replaced. Ten grammes per cup are sufficient, and 5 to 8 grammes only for the "pot." When the water begins to boil, which is indicated by the steam condensing in C, the cock, V, is shut. The water then mounts, and on its arrival at half the height of the filtre the spirit lamp may be extinguished. The greatest attention during the process must be paid to the last instructions; the water must not come over too quickly or too slowly. The first regulator, *r*, is that attached to the spirit lamp; the second is the steam cock, V. If the water pass too freely, and is likely to overrun the apparatus, on opening the steam cock the restored equilibrium prevents the ascent of the water. This coffee pot is *unexplosible*, as neither steam nor water can exert much pressure on the part, C, which is only lightly closed by a lid; it is one of the few articles of this class that do not present a clumsy or tinker-like appearance on a table, as it is composed chiefly of glass, except the portion over the flame, which may be made of porcelain or metal if required.



An Inquiry on Fortifications.—The secretary for War has issued the following instructions for the guidance of the committee recently appointed to inquire into the construction, condition, and cost of fortifications:—"It appears to me extremely desirable (having reference to questions recently raised in the House of Commons) that a full inquiry should be made into the construction, condition, and cost of the fortifications and works erected, or in the course of erection, under the 30 and 31 Vict. c. 145, and previous statutes, by a competent committee. I have the honour to inform you that the officers and gentlemen named in the margin have consented to undertake such inquiry, under your presidency, and to report to me the result. Plans of the works in course of construction will be laid before you, and accepting as approved the position of the forts, and the general design of the works, the matters upon which I desire the information and the opinion of the committee are—1. Whether these forts and works have been well and skilfully constructed, with reference—(*a*) To their stability and permanency. (*b*) To the arrangements made, or proposed to be made in them for the service of the guns, and otherwise to meet the requirements of a modern armament. (*c*) To the power of resistance (offensive and defensive) that they offer to any attack to which they may be exposed. (*d*) To the cost incurred and to the future expenditure that may be needed for their completion (if this inquiry can be readily accomplished by the committee, and without involving them in a considerable sacrifice of time). 2. Whether any and which of the works, so far as the same have yet proceeded, are, with reference to their foundations, or otherwise in an insecure condition, and need any and what support or reparation, and what would be the probable cost of such support or reparation? 3. Whether the estimates in the schedule of the Fortification Act of 1867, before referred to, will suffice for the completion of the works as contemplated, and if not, what additional sums will probably be required. 4. For the purpose of enabling you to carry out this inquiry, I have requested his Royal Highness the Field Marshal Commanding-in-Chief to cause the general officers commanding at the stations to be instructed to give the committee all requisite facilities. I have also desired the officers of the War Department to give you the fullest information upon every matter upon which the members of the committee may require it; and I have to express a hope that the inquiry will be conducted with as little delay as may be compatible with full investigation and report, and that the committee will, if they deem it to be expedient, make a preliminary report on any of the subjects of inquiry.—I have, &c., J. S. Pakington."

The Post-office in 1866.—The number of letters delivered in the United Kingdom in 1866 is stated, in round numbers, at 750,000,000, an increase of 4 per cent. over the number in the preceding year. This gives an average of 24 letters to each person; in England 30 letters to each person, in Scotland 22, in Ireland 10. The number of book packets, newspapers, and pattern packets delivered by post in the United Kingdom in 1866 advanced to 101,784,185. Money orders were issued in 1866 for £18,847,643. The depositors in post-office savings-banks at the end of the year 1866 were 754,258, an increase of 23 per cent. over the preceding year. The balances due to depositors, £8,121,175, showed an increase of 24 per cent. The number of policies of insurance effected with the government through the post-office increased from 560 at the close of 1865 to 1150 at the close of 1866; the amount insured from £41,734 to £86,593. The number of immediate annuities from 94 to 283; the amount from £2236 a year to £6427. The number of deferred annuities from 54 to 107.

Smoking Pipes.—Mr. T. M. Hammond, of Montreal, Canada, has patented (11th January, 1868) certain improvements which relate to the employment of a peculiar material, or combination of materials, for the construction of the bowl, or the bowl and stem of smoking pipes, and consists essentially in the use of pulverized charcoal, carbon, or peat, in combination with the pulverized residuum of cannel coal, or other analogous substance or compound, treated as follows:—The charcoal or carbon is first reduced by grinding or pulverizing to an impalpable powder. The article used in commerce, and known as distilled "residuum of cannel coal," is also reduced by grinding, pulverizing, or otherwise, to an impalpable powder, or, in place of the residuum of cannel coal, asphaltum or other analogous compound may be employed. These two preparations are then thoroughly incorporated or mixed with each other in the proportion of about two-thirds of the first to one-third of the last, or residuum. These proportions will give a good result, but other proportions may be employed. This compound is then placed in a suitable iron or metal mould, arranged in the form of the bowl of a pipe, of any suitable form or size. This metal mould is heated to the boiling temperature, or about 212° Fahr. In some forms of moulds plungers are so arranged as to form the cavities of the bowl, and also in the shank to which the perforated stem is attached. These plungers are actuated by hydraulic, screw, or other pressure, and in their progress condense the material placed in the mould into a compact or solid condition. This pressure, acting in combination with the heat, reduces the compound to a homogeneous mass by the melting and thorough incorporation of the oil or gum contained in the residuum, or other material employed with the pulverized carbon.

Magnesian Refractory Bricks and Crucibles.—Mr. H. Caron has explained, in a memoir recently laid before the Academy of Sciences, the method of preparing magnesia, with a view to render it available as a refractory material. The refractory nature of magnesia has been known for a long time, but its high price has prevented its being used except in laboratories. The circumstances are now happily changed; the recent improvements in the manufacture of cast steel, the adoption of Siemens furnaces and the Martin and other processes require imperatively the employment of bricks at any cost, more refractory than those actually in uso. On the other hand the carbonate of magnesia, which formerly cost £10 a ton, can be had for £2 16s., delivered at Marseilles, or £4 a ton delivered at Dunkirk. The calcination on the spot of the carbonate before expedition would lower the price still more.*

The magnesia employed by Mr. Caron, up to the present time, is obtained from the island of Eubœa, where it is found in considerable quantities in the state of a very compact, white, and rather hard carbonate. It contains traces of lime, silica, and iron; it is also sometimes traversed by serpentine and large plates of silex, which would diminish the infusibility of the magnesia and render it unavailable, especially for the oxyhydrogen light, if they were not eliminated. With regard to refractory bricks, the presence of a small quantity of foreign matters can only, at very elevated temperatures, give rise to a slight vitrification which is attended with no serious inconvenience.

The carbonate in lumps is first burned at a temperature sufficient to drive off the carbonic acid; the magnesia then becomes friable and pulverulent. At this stage the serpentine and silex, easily distinguished by their not becoming friable, can be separated. This first treatment does not yet permit the magnesia to agglomerate; and even if it did, a higher temperature than that of the first calcination, giving rise to an enormous contraction, would cause cracks and deformities which would interdict the use of this substance. It is therefore indispensable that the magnesia, before being moulded, be submitted to at least the same temperature as that which it is hereafter required to bear.

Thus calcined, it is in no way plastic; it has a sandy aspect, and it acquires no cohesion by compression. In order to impart to it this property, it is only necessary to mix it with a small quantity of magnesia less calcined.†

All that is necessary now is to wet the mixture with 10 or 15 per cent. of its weight of water, and then to compress it strongly in cast-iron moulds in the same manner as agglomerated coal. The brick thus produced hardens on exposure to the air, and becomes more resisting on being calcined at a red heat. The same process would seem, at first sight, available, by varying the form of the mould, for obtaining large crucibles; but the compression is difficult in large masses, and also in the case where moulds have a large surface, as the magnesia adheres strongly to the sides. Although M. Caron had obtained small laboratory crucibles by this method, he does not consider it applicable to large crucibles for the fusion of steel. It is preferable in this and some other cases to agglomerate the magnesia in another manner.

In order to give the magnesia a sort of plasticity, M. Caron has taken advantage of a property of this earth cited in Berzelius' work on Chemistry. When highly calcined and then moistened, it hardens on drying. This fact is due no doubt to a hydration which, however, is unattended with any sensible elevation of temperature. It is remarkable also that magnesia solidified by this method does not lose the combined water, except at an elevated temperature; then the calcination not only does not cause disintegration, but on the contrary imparts to it a hardness and a resistance comparable to those of ordinary crucibles after being baked.

Thus, the magnesia for the manufacture of crucibles, after being calcined, should be simply wetted, heaped into the mould, dried, and then baked. For the lining of furnaces for melting steel, the magnesia paste is laid on the sides in the same manner, and may be baked without any particular precautions being necessary. It sometimes, however, occurs, either from the magnesia having been too much or too little hydrated, or from its containing silicious matters, that the vessels after being baked do not possess all the solidity desirable. They should then, in order to acquire it, be simply steeped in water saturated whilst cold with boracic acid, and then dried and baked as before. This operation does not render the magnesia less infusible; it only causes the particles to adhere more strongly together.

Very pure magnesia, highly calcined and finely pulverized, can also be employed in the state of *barbotine*, and will form the most delicate and transparent crucibles, as well as receive the finest and most complicated impressions. At some future period magnesia may be employed advantageously in the ceramic art, notwithstanding the difficulty of moulding it as compared with porcelain clay.

Hydraulic Cylinder.—An engineer in Berlin gives the following as a method of effectually stopping up a porous cylinder cast for a hydraulic press. The cylinder is to be heated over a charcoal fire to about 170 degs. Fahr. It is then to be filled up with resin and suspended by a crane over the fire until the liquefied resin is seen sweating through on the outside. The excess of resin is then poured out and the cylinder allowed to cool, when the pores will be found completely stopped, and no water can possibly pass.

An Improved Lock has recently been patented by W. A. C. Oakes, of Reading, U.S., A.; these improvements embrace, firstly, such a peculiar construction of the follower and bolt, or its slide, as that the back movement of the latch bolt is effected for a given distance only by the follower, sufficient to secure the unlatching of the bolt, after which the latter is restrained by the follower from further motion backwards, though free to be otherwise forced inwards to effect reversal of the bolt. It also consists in such a construction of the follower arms and bolt as that, when the bolt is pushed back beyond the limit of its action by the follower, the arms are or may be disengaged from the bolt, to allow of the protrusion of the latter for the purpose of effecting its reversal. It also consists in a combination of an arm or projection provided on the sliding yoke and screw holding the lock to its place, to prevent the reversal of the bolt when the lock is on the door; and it further consists in a combined free or loose attachment of the latch bolt and spring to shoot and hold it in place.—*American Artizan.*

Imitation Precious Stones.—Pending the discovery of the means of artificially producing real precious stones—that is, of forming by art stones having the exact chemical composition and appearance of those formed by nature—and the arrival of the day predicted by Alphonse Karr, when a chemist shall present to the Academy of Sciences a diamond as large as a hen's egg, and apologize for the smallness of the specimen, many vain persons will have to indulge their vanity by the display of sham jewels. It is right to say, however, that (thanks to the researches of Ebelmen, Deville, Troost, and others) small rubies and amethysts have been produced, and even microscopic diamonds have been made. But while we have to wait for larger productions it is well to have the imitations as exact and beautiful as possible; therefore we copy from "Elsner" a receipt for a hard foundation glass, and the proportions of colouring agents necessary to give this glass the appropriate tints of the stones. Elsner takes 45·7 grammes of pure quartz, 22·8 grammes of pure and dry carbonate of soda, 7·6 grammes of borax, 3·4 grammes of nitre, and 11·8 grammes of minium. These ingredients, reduced to a fine powder and well mixed, are brought to perfect fusion in a Hessian crucible over a charcoal fire. To colour this mass, in order to imitate various precious stones, the following must be added:—For sapphires, 0·106 grammes of carbonate of cobalt; for emeralds, 0·53 grammes of oxide of iron; for amethysts, 0·265 grammes of carbonate of manganese; for topaz, 1·59 grammes of oxide of uranium. In all cases the fusion must be perfect, or a clear glass will not be obtained. Cutting greatly improves the appearance of these imitations.—*American Artizan.*

An Improved Gauge for Sewing Machines has recently been patented by Charles Benedict and O. K. Tyler, of Walcottsville, Conn., whereby greater convenience is afforded for sewing or stitching at a uniform distance from the concave and angular edges of cloth and other material, as well as from edges of other forms and configurations, and whereby the edge of the cloth is prevented from over-sliding the gauge during the operation of sewing, thereby insuring more uniformity of width to the hem.—*American Artizan.*

Pencils of Artificial Coal have been made by Mr. F. Carre, the illuminating power of which, by the aid of electricity, has been found much superior to that obtained from the coal supplied by the gas-works. To make this substitute he takes various kinds of sea coal and charcoal reduced to impalpable powder and then washed in acids; they are next ground with fine oils mixed with resins; and, lastly, subjected to a powerful pressure, strongly agglomerating them into prisms or cylinders, which are subsequently calcined in close vessels at a white heat. By addition of iron or antimony the electric power is considerably enlarged. —*American Artizan.*

The Ice Trade.—The trade in ice is of two kinds—the rough or local ice, which the coster gathers from the ponds and the artificial pieces of water. and the foreign ice, which is used principally for table purposes. The glittering cubes of pure crystal we are accustomed to see on the fishmongers' slabs and in the windows of the

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* This first calcination requires less heat than that of lime, and causes the carbonate of magnesia to lose half its weight.

† The quantity of this last necessarily varies with the degree of calcination of the two magnesias; it is about $\frac{1}{6}$th of the weight of that which has been subjected to the greatest heat (fusion of steel), in fact the least possible quantity necessary to insure good agglomeration.

Wenham Lake Ice Company are all procured from Norway. A few years since this company procured their supply from Wenham Lake, near Boston, but the expense of freight rendered it so costly that they were obliged to seek for sources nearer home. In the hills situated a few miles from Drobäk in Christiania Fjord there is a very pure lake, fed entirely by springs, belonging to this company, and from this source all the pure table ice is now supplied. There is a notion that water while in the act of congelation is purged from all foreign matter. This is only partially true. All its mineral salts and any colouring matter it may contain are removed from it, but no organic matter is eliminated in the process. For this reason the clearness of the ice is no test of its purity; many a glittering lump when it dissolves absolutely smells. We state this by way of caution to those who think that the eye is the most perfect test of the purity of this grateful addition to the table. The Wenham Lake Ice Company, when they had satisfied themselves that the piece of water from which they secure their supplies was free from any impurity, not only purchased the lake but the farms surrounding it, in order to keep it in their own hands and secure it from any deleterious local drainage; and it is from this crystal cup that their translucent crops are gathered year by year, The process of reaping the ice crop is the same in Norway as in America. By the aid of a sharp ice plough the surface is ruled with parallel lines 21 inches apart; when the whole surface is marked in one direction the plough is set to work at right angles. In this manner the whole surface is divided like a chess board into squares 22 inches square and about a foot in depth; the ice saw divides these parallel lines, and by the aid of the ice spade, a sharp wedge-like implement, the squares are split apart with the utmost rapidity. In America, where the weather is at times changeable, the greatest anxiety is felt while the process of reaping is being carried on, lest a thaw should come on and spoil the harvest. It is gathered in as fast as possible into the ice houses, which are, in fact, enormous refrigerators, built of pine-wood, with double walls 2 feet apart, the intervening space being filled in with sawdust, which is one of the cheapest and most readily procurable nonconductors. In Norway, where the cold weather is not so liable to be broken up as in America, the harvest is gathered more at leisure; it is secured in the same manner, however, and the ice stores are on a very large scale, sufficient to afford a supply for two or sometimes three years. It seems absurd to talk of ice two years old; to keep the hand of Time from such a perishable article seems an absurdity, but as a fact, much of the table ice now supplied to us was reaped in the latter end of the year 1866. We are speaking now of the ice supplied by the Wenham Lake Ice Company. This company prides itself upon supplying only pure ice, but there is scarcely a fjord in Norway in which some trading vessel is not frozen in during the winter months, during which they ship a cargo and run over to England with the first favourable wind. The voyage with a fair wind is not more than four days, hence this island imports nearly the whole of the crop. Thus, in 1865, out of 44,823 tons exported, this island received 43,359 tons. The block ice is filled in with rough ice, and during its transport to the ice stores of the company loses ten per cent. These blocks of ice are treated just like blocks of stone; the tools they are lifted with are similar. Considering the quantities that are dealt with, a certain rough handling is unavoidable. When hoisted out of the ship's side they are placed in barges, and conveyed up to the storehouses, protected from the sun only by a tarpauling, and that a black one. It is therefore extraordinary that the loss by melting is not more than it is during transport. The loss is at least 50 per cent. before it is vended to the purchasers. When the ice blocks are stored sawdust is placed in layers between them, and in this manner the rough Cyclopean masonry is built up. If the blocks were placed one upon another without the interposition of any nonconducting substance the whole would become frozen into one solid mass, which would be very difficult to deal with. The blocks, weighing 1 cwt. and ½ cwt., are forwarded to customers in the country packed in bags filled with sawdust. The value of ice as a preserver of life, as well as of animal food on the long voyage to our antipodes, has lately been shown in the successful transportation thither of salmon ova. After many failures, consequent upon attempts to preserve them in the same manner as in this country—namely, by placing them in a running stream of water—at the suggestion of Mr. Moscrop, of the Wenham Lake Ice Company, they were packed in moss and placed between blocks of ice in the icewell of the ship conveying them. The last experiment succeeded, and young salmon are now plentiful in the rivers and preserves of Tasmania. In return for thus exporting a valuable form of fish life to our distant children, they, as in duty bound, have attempted to make some adequate return—to send to the mother country some portion of the animal food which is a mere drug in their own market. Cargoes of beef and mutton in the carcass have been packed in ice and sent home. It arrived quite fresh, but the failure of this process, by which it was hoped to have fed one hemisphere with the redundance of another, was owing to the fact that iced meat requires to be consumed immediately; the moment the protection of the ice is removed decomposition sets in with a rapidity which prevents any delay in the hands of the salesman. We may mention, by the way, however, that ice having failed, the chemical process of preservation of animal substances, known as Dr. Medlock's process, is possibly destined to accomplish the end required, and experiments are now being carried on by the Society of Arts to test its value.—*Times.*

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

11*th August*, 1868.

2499 R. Robinson, Preston—Regulating the speed of shafts and machinery
2500 W. H. Hunt, Liverpool—Constructing baskets
2501 J. Brown, South Stöckton—Rolling iron and steel
2502 A. M. Clark, Chancery Lane—Propelling vessels
2503 J. Salmon, Manchester—Printing machinery
2504 H. Moore, T. Moore, and G. Moore, Birmingham—Decorating houses
2505 M. Gray, Highbury Hill, and T. Hawkins, Silvertown—Telegraphic wires
2506 J. H. Johnson, Lincoln's Inn Fields—Railways.—A com.
2507 A. Argamakoff, St. Petersburg—Producing printing surfaces by photography adapted to lithography
2508 J. M'Farlane, Edinburgh—Paper-making machines
2509 J. R. Croskey, Cannon Street—Looms for weaving

12*th August*, 1868.

2510 E. P. G. Headley, Cambridge—Extinguishing fires
2511 D. Hill, J. Richardson, C. G. Johnson, Stockton-on-Tees, J. N. Duck, Redcar, and W. F. Mastermann, Whitby—Iron and steel
2512 J. Winsborrow, Dalston—Liquid measuring apparatus
2513 J. T. Pendlebury and T. Pendlebury, Bury—Valve motion
2514 J. Thompson, Handsworth—Utilizing scrap iron
2515 J. Broad, Arthur Street, West—Manufacturing paper
2516 H. H. Henson, Westminster—Metallic ropes
2517 C. D. J. Seitz, Bury—Furnaces
2518 J. Wilson, Salford—Blinds for windows
2519 R. H. Southall and W. Hallam, Manchester—Protecting the elastics of boots
2520 H. Dewhurst, J. W. Dewhurst, and R. E. Dewhurst, Huddersfield—Ornamenting seal-skin cloths
2521 H. Lunn, Horncastle—Sample bags
2522 J. Cleaver, Nottingham—Ornamenting lace
2523 R. C. Rapier, Westminster—Electric clocks
2524 H. B. Walker, Bradford—Extracting burs from wool
2525 W. Payne, Balham—Locks or valves
2526 G. A. Buckholz, Shepherd's Bush—Hulling grain
2527 J. Petrie, Rochdale—Wool-washing machinery
2528 W. E. Newton, Chancery Lane—Photographic frames.—A com.
2529 R. Sim, Naples—Preventing the fouling of ships' bottoms

13*th August*, 1868.

2530 F. Barnett, Paris—Apparatus for swimming
2531 W. Thorold, Norwich—Railway rolling stock
2532 R. Saunders, Croydon—Anchors and tackling
2533 J. Grant, Hampstead—Turning over the leaves of music books
2534 J. M. Milbank, Connecticut—Breech-loading fire-arms
2535 B. Ingham, Bradford—Dyeing worsted
2536 H. Steffanson, Brompton, and J. Hadley, Upper Thames Street—Decorticating grain
2537 J. Holding, Wheelton—Looms for weaving
2538 S. C. Lister, Manningham—Wool-combing machinery
2539 T. R. Crampton, Westminster—Grinding coal
2540 H. K. York, Cardiff—Treating cast iron

14*th August*, 1868.

2541 H. B. Binks, Kingsland—Preparing indigo for laundry purposes
2542 W. Shaen, Holborn—Manufacturing explosive compounds.—A com.
2543 E. Evotte, Paris—Cutting wooden cogs of cog wheels
2544 G. Nelson, Leeds—Disinfecting apparatus
2545 J. B. Thompson, Horton—Coating iron with gold
2546 W. E. Newton, Chancery Lane—Combing silk.—A com.

15*th August*, 1868.

2547 J. Macintosh. Regent's Park—Submarine telegraphy
2548 C. D. Abel, Chancery Lane—Producing brown colouring matters.—A com.
2549 J. J. and W. Fletcher, Salford—Grinding machinery
2550 J. Hickisson, Southgate Road—Pencils
2551 R. Robinson and E. D. Edmeston, Preston—Lathes
2552 A. J. Leak, Hanley, and E. Leak, Longton—Manufacturing pottery articles
2553 H. Reissmann, Watling Street—Fountains.—A com.
2554 H. Y. D. Scott, Ealing—Kilns
2555 C. Mohr and S. E. Smith, Birmingham—Manufacturing cages
2556 A. M. Clark, Chancery Lane—Manufacturing size.—A com.
2557 J. H. Dearle, Camden Road, and T. Brown, Piccadilly—Tents
2558 W. B. Espeut, Hyde Park—Treating sugar

17*th August*, 1868.

2559 W. J. Hinde, Burwash—Raising and burning out the ends of candles
2560 A. Smith, Glasgow—Manufacturing sugar.—A com.
2561 E. Beanes, Maidenhead—Manufacturing brewers' finings
2562 B. Hunt, Lincoln's Inn—Decomposing the sulphurets of iron ore
2563 B. P. Stockman, Westminster—Water meters
2564 W. E. Newton, Chancery Lane—Fog alarum.—A com.
2565 J. Palmer, Merrimac—Carriage springs
2566 W. Edwards, Redditch—Sewing machine needles
2567 J. H. Johnson, Lincoln's Inn Fields—Machinery for cleaning grain.—A com.
2568 G. F. Bradbury and T. Chadwick, Oldham—Sewing machines.—Partly a com.
2569 W. Corbitt, Rotherham—Decorating stoves
2570 C. J. W. A. and F. Simpson, Preston—Dyeing yarns for weaving
2571 A. Albini and J. Vaglica, Broad Street—Electro-magnets
2572 H. J. Behrens and E. Dait, Paris—Rotative engines
2573 J. Phillips, South Hampstead—Stoves and fireplaces

18*th August*, 1868.

2574 J. Briggs, Kingsland Road—Cork-cutting machinery
2575 J. G. Tongue, Chancery Lane—Mills for grinding.—A com.
2576 D. G. Fitzgerald, Battersea—Electric telegraphs
2577 J. S. Starnes, Ratcliff—Ships' signal lamps
2578 P. R. Hodge, Adelphi, and W. Hodge, Fowey—Manufacturing paints
2579 D. Fraser, Arbroath—Spinning flax
2580 J. Landless, Manchester—Steam boilers
2581 E. Ledger, Peckham—Obtaining motive power
2582 L. Gay, Rheims—Wool-washing machinery
2583 W. Thomson, Glasgow—Expanding and cutting tubes

19*th August*, 1868.

2584 E. Deane, Arthur Street—Cooking apparatus
2585 J. Neumann, Paris—Purifying coal lighting gas
2586 J. H. Atterbury, Ferrybridge—Manufacturing earthenware articles
2587 J. Norbury and J. Shaw, Salford—Force pumps for hydraulic presses
2588 F. Braby, Camberwell—Utilizing waste sulphate of iron solution
2589 A. Clark, Chancery Lane—Tanning leather.—A com.
2590 W. H. Davey, Caledonian Road—Drying linen
2591 J. Heaton, Langley Mill—Rails for railways

20*th August*, 1868.

2592 T. R. Shaw, Pendleton—Oil testers
2593 W. J. Almond, Cheapside—Preparing cotton threads
2594 J. Sawyer, New North Road—Constructing window sashes
2595 G. Calkin, Regent's Park—Pianofortes
2596 H. N. Waters, Connecticut—Feed-water heaters
2597 P. Robertson, Mincing Lane—Railway breaks
2598 A. Rollason, Commercial Road—Purifying coal gas
2599 H. Hughes, Homerton—Sewing machines
2600 H. C. Eusell, St. Helens—Smelting copper
2601 A. V. Newton, Chancery Lane—Rotary engines.—A com.

21*st August*, 1868.

2602 T. Haigh, Liverpool—Apparatus for brewing
2603 J. Elliott, Southampton—Cutting stone

2604 E. J. E. Niepce, Paris—Safety blinkers.—A com.
2605 J. H. Johnson, Lincoln's Inn Fields—Manufacturing flour.—A com.
2606 P. N. Hasluck, Tottenham Court Road—Register for vehicles
2607 F. J. Knewstub, Westminster—Despatch boxes
2608 T. W. Rammell, Westminster—Rotary machines
2609 J. L. Clark, Sydenham Hill—Communicating in railway trains
2610 B. Walker and J. F. A. Pflaum, Leeds—Rolling disc wheels
2611 D. Evans, South Hackney—Manufacturing metallic casks
2612 J. Tall, Southwark—Constructing houses

22nd August, 1868.

2613 T. Wrigley, Manchester, and J. Holding, Wheelton—Looms for weaving
2614 A. B. Childs, Mark Lane—Dressing millstones
2615 W. J. Kesselmeyer and C. A. Kesselmeyer, Manchester—Governors for steam engines.—Partly a com.
2616 F. M. B. Bertram, Ludgate Hill—Obtaining illuminated devices
2617 J. Watson, Sunderland—Blast furnaces
2618 R. D. Morgan, Tyn-y-coed, Rhyl—Swimming apparatus
2619 G. H. Barber, Southampton—Preserving meat
2620 H. Thompson, Islington—Roughing horses
2621 W. R. Lake, Chancery Lane—Uniting the ends of railway rails.—A com.
2622 W. J. Sallitt, Leeds—Gravitating wheel engine.

24th August, 1868.

2623 W. Chorlton, Manchester—Heald warpers
2624 C. George, Dulwich—Artificial horizon
2625 G. Tidcomb, Bushey—Removing dirt from boots
2626 A. F. Eckhardt, Hamburg—Preparing grain before sowing
2627 A. Goodman, Newcastle-on-Tyne—Steam boilers
2628 W. R. Lake, Chancery Lane—Cartridges
2629 O. C. Setchell, Commercial Road—Manufacturing bricks
2630 W. H. Tooth, Greenwich—Manufacturing bricks
2631 G. J Colette, High Holborn—Holders for sewing needles
2632 G. S. Dracopulo, Cardiff—Apparatus for raising water
2633 H. Ground, Norwich—Bushing the bungholes of casks

25th August, 1868.

2634 J. Jeavons, Sheffield, and C. Martin, Chancery Lane—Manufacturing iron for plating vessels
2635 R. Couchman, Noble Street—Dress fastenings
2636 R. Scholefield, Leeds—Brickmaking machinery
2637 C. J. R. Jähns, Liverpool—Obtaining motive power
2638 W. C. Cambridge, Bristol—Breaking and reducing land
2639 B. J. Cohen, Hamburg—Receiving communications
2640 J. S. Adcock, Birmingham—Keeping accounts
2641 J. Barrans, Leeds—Flattening the heads of needles
2642 J. J. Long, Glasgow—Reducing and cutting timber
2643 J. Gillott, Chapeltown, and P. Copley, Warren—Machinery for cutting coal
2644 J. H. Johnson, Lincoln's Inn Fields—Condensing vapour.—A com.
2645 A. M. Clark, Chancery Lane—Breech loading fire-arms —A com.
2646 R. Harvey, Bristol—Sewing machines
2647 A. E. Borgen, Seething Lane—Manufacturing stearine.—A com.

26th August, 1868.

2648 J. Dawson, Thames Ditton—Shaft tug
2649 S. Morris, Ashton-under-Lyne—Spinning and doubling
2650 J. Hamer, Bolton—Looms for weaving
2651 W. Hall, Nottingham—Rotary engines
2652 R. W. Morgan, Dublin—Reaping and mowing machine
2653 W. Houghton, Leeds—Looms for weaving
2654 W. L. Williams, Liverpool—Motive-power engine
2655 E. Zoepfel, Manchester—Rendering doors and windows water-tight
2656 S. R. Samuels and J. Birks, Nottingham—Manufacturing woven fabrics
2657 J. Hanson, Lincoln—Breech-loading fire-arms

27th August, 1868.

2658 A. Lupton, Chesterfield—Generators for steam
2659 T. Wrigley, Todmorden—Furnaces
2660 W. M. Jackson and R. Garsides, Kingston-upon-Hull—Roofing tiles
2661 E. Peyton, Birmingham—Metallic bedsteads
2662 L. P. Hebert, L. A. Moulin, Neuilly-on-Seine, and J. P. Couinek, Rue du Marche—Presses for stamping letters
2663 D. Smith, Chancery Lane—Smoke-consuming apparatus

28th August, 1868.

2664 B. Burrow, Leicester—Separating skeins of silk
2665 N. J. Holmes, Regent's Park—Electric telegraphs
2666 J. Yule, Glasgow—Treating sewage
2667 W. Strang, Glasgow—Treating sewage
2668 G. Ker, Maidstone—Cleaning gloves
2669 T. Henderson, Glasgow—Sewing machines
2670 B. Corcoran and W. Dunham, Mark Lane—Dressing millstones
2671 R. Saunders, Croydon—An oscillating screen breakwater
2672 W. M'Gregor, Notting Hill—Telegraph posts
2673 C. H. Gardner, Fetter Lane—Lithographic printing machine

29th August, 1868.

2674 E. Richardson, Wapping—Coverings for bottles
2675 H. Potter, Belfast—Bleaching cotton
2676 J. Martin, Manchester—Extracting pitch from wool
2677 W. E. Gedge, Strand—Agglomerating coal dust
2678 J. Tattersall, T. Tattersall, and T. Richmond—Grinding "cards" for preparing cotton
2679 E. Jackson and J. Ogden, Chadderton—Preparing cotton
2680 J. M. Hunter, New Jersey—Aerial apparatus
2681 E. L. Paraire, Regent's Park—Working steam engines
2682 W. Naylor, Mildmay Park—Railway breaks
2683 T. Varley, Breckenham—Electric telegraphs

31st August, 1868.

2684 W. S. Fletcher, Manchester—Preventing draughts in doors
2685 S. Newton, Oldham—Swing-door hinges
2686 J. Greenwood, Limeholm—Looms for weaving
2687 T. Lester, Wordesley, and W. Trueman, Brierly Hill—Steam engines
2688 J. Fieldhouse, Birmingham—Furnaces
2689 H. Walker, Alcester—Putting up needles for sale
2690 J. Wilkinson, Leeds, Printing carpets
2691 W. R. Lake, Chancery Lane—Wire rigging.—A com.
2692 W. R. Lake, Chancery Lane—Projectiles.—A com.
2693 W. E. Gedge, Strand—Warding off leaves from turbines.—A com.
2694 N. Thompson, Brooklyn—Cutting nippers
2695 L. F. A. P. Riviere, Cognac—Packing bottles

1st September, 1868.

2696 J. C. Martin, Barnes—Gelatine
2697 J. and W. Badger, Rotherham—Steam engines
2698 J. Ladley, Leeds—Wool-twisting machinery
2699 F. Hudson, Blackfriars' Road—Gas meters
2700 W. C. Holmes, Gracechurch Street—Manufacturing gas.—A com.
2701 T. Toms, Lambeth—Waterproof boots
2702 T. G. F. Dolby, Old Town—India rubber valves
2703 E. Jobson, Dundee—Pianofortes
2704 W. R. Lake, Chancery Lane—Looms for weaving.—A com.
2705 W. W. Macvay, Castleford—Glass furnaces

2nd September, 1868.

2706 H. A. Bonneville, Piccadilly—Regenerating alimentary substances.—A com.
2707 J. H. Greener, Adelphi—Insulators for telegraph wires
2708 J. Adams and H. Barrett, Jersey—Stopper for bottles
2709 E. Cortazzi, New Cross—Suspended iron roads.—A com.
2710 C. E. Brooman, Fleet Street—Purifying wool.—A com.
2711 H. Aitken, Falkirk—Treating grain
2712 J. F. C. Carle, Leadenhall Street—Breech-loading needle guns
2713 J. Evans, Wednesbury—Finishing iron
2714 J. J. Campbell, Reading—Securing bales of cotton
2715 T. Forster, Streatham Common, and J. Heartfield, Croydon—India-rubber

3rd September, 1868.

2716 W. C. Green, South Molton Street—Breech-loading fire-arms
2717 J. Neumann, Bedford Square—Puzzling fan
2718 F. Preston and R. C. Ross, Manchester—Stop blocks for railways
2719 A. C. Kirk, Glasgow—Packing ice.—A com.
2720 J. Griffiths, West Firle—Apparatus for uprooting trees
2721 A. M. Clark, Chancery Lane—Combined portable bedstead and travelling trunk.—A com.
2722 E. L. Parker, Birmingham—Fastening for braces

4th September, 1868.

2723 T. Atherton and J. Atherton, Preston—Looms for weaving
2724 S. Grafton, Birmingham—Cucumber-slicing apparatus
2725 J. H. Johnson, Lincoln's Inn Fields—Preparing a blue colour from aniline.—A com.
2726 G. White, Cheapside—Preventing incrustation in steam boilers.—A com.
2727 T. Butterworth, Oldham—Pumps
2728 D. Jones, Malvern Wells—Umbrella stands
2729 A. M. A. Laforgue, Caen—Pulviphorous apparatus
2730 C. Travis, J. Chadwick, and J. Law, Rochdale—Carding engine condensers
2731 W. G. Cooper, Burnley, and R. Harrison, Britannia—Looms for weaving
2732 J. Sproul, Hadley—Water power
2733 W. E. Newton, Chancery Lane—Thermometers.—A com.
2734 J. Parker, Camberwell—Obtaining motive power
2735 S. Sharrock, Liverpool—Metallic standards for telegraph posts
2736 T. Perkins, Hitchin—Apparatus for raising agricultural produce on to carts

5th September, 1868.

2737 J. Pickering, Stockton-on-Tees—Apparatus for lowering weights
2738 R. Banks, Saddleworth—Floor cramp
2739 T. Howcroft and A. M'Gregor, Bedford, Leigh—Reaping and mowing machines
2740 J. L. Pulvermacher, Regent Street—Producing electric currents
2741 J. Sloper, Walbrook—Perforating railway tickets
2742 W. H. Crispin, Stratford—Artificial fuel
2743 W. E. Newton, Chancery Lane—Mariners' compasses.—A com.
2744 T. Wilson, Birmingham—Breech-loading fire-arms
2745 W. Tatlock and C. N. Abelseth, Chancery Lane—Manufacturing gas.—A com.

7th September, 1868.

2746 H. Cowing, Euston Square—Steam ploughs
2747 J. Wood, New Jersey—"Frog-plates"
2748 C. E. Brooman, Fleet Street—Burning mineral oils —A com.
2749 H. M. Lee, Manchester—Cases for containing visiting cards
2750 U. A. Masselon, Issoudun—Kilns for burning bricks
2751 J. Joynson, Manchester—Muffs
2752 G. Davies, Lincoln's Inn—Water meter.—A com.
2753 W. T. Carrington, Westminster—Capstans
2754 V. Wanostrocht, Walbrook—Manufacturing gunpowder
2755 A. V. Newton, Chancery Lane—Knitting machinery.—A com.
2756 E. E. J. and H. Stokes, Aston—Bracelets
2757 J. C. Walker, Hackney Wick—Boilers for boiling articles of clothing
2758 S. B. Tucker, Chancery Lane—Rotary engines.—A com.
2759 C. Holland, Chicago—Artificial stones.—A com.

8th September, 1868.

2760 F. Andoe, Swansea—Lowering apparatus
2761 J. Jones, Consett Ironworks—Constructing furnaces
2762 J. Burdett, Harrow Road—Machinery for making bricks
2763 A. R. Stocker, New Cross, and J. A. Edgley, Lamb's Conduit Street—Caps
2764 A. J. Fraser, Holloway—Locks
2765 G. Lowry, Salford—Carding machines
2766 J. Aub, Paris—Match boxes
2767 P. J. Soulage, Paris—Pin for jewellery
2768 E. Cottam, Battersea—Horse shoes
2769 J. Stewart and J. Nicholson, Poplar—Expansion engines
2770 T. E. Clarke, Apsley Cross—Fireplaces
2771 S. Benjamin, Bayswater—Blinds for hansom cabs
2772 G. Warsop, Nottingham—Obtaining motive power
2773 E. Johnson, Brighton—Manufacturing muffs

9th September, 1868.

2774 J. Millward, Birmingham—Steam boilers.—A com.
2775 J. Adams and H. Barrett, Jersey—Manufacturing aerated beverages
2776 L. B. Covert, New York—Extension ladders
2777 A. M. Clark, Chancery Lane—Metallic spring packages.—A com.
2778 A. M. Clark, Chancery Lane—Envelopes
2779 E. Wood, Bolton—Steam engines
2780 A. V. Newton, Chancery Lane—Pumps.—A com.

10th September, 1868.

2781 J. Shand, Blackfriars—Steam boilers
2782 G. Davies, Lincoln's Inn—Stamping leather
2783 T. Bennett, Birmingham—Manufacturing spoons
2784 A. A. Lejeune, Manchester—Manufacturing colours
2785 E. Padley, Tipton—Anchors
2786 S. G. Archibald, Edinburgh—Apparatus for reaping
2787 W. M'Naught, Rochdale—Steam engines
2788 J. Maynes, Manchester—Looms
2789 A. B. Ibbotson, Sheffield—Railway fastenings.—A com.
2790 C. H. J. Matton, Regent Street—Stockings
2791 S. Tragheim, Gray's Inn Road—Apparatus for cleansing fibrous materials
2792 J. Challender and B. Kitchen, Manchester—Signals
2793 J. Oliver and C. O. M'Allum, Newcastle-upon-Tyne—Utilization of saline salts
2794 A. Cruls, Brussels—Manufacturing cement tiles
2795 W. R. Lake, Chancery Lane—Condensing apparatus for steam engines.—A com.
2796 A. C. Henderson, Charing Cross—Ornamenting boots.—A com.

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SELF CONTAINED BAR-BOILER.

GEORGE BOWER,
Patentee.
St NEOTS HUNTS.

Fig. 1.

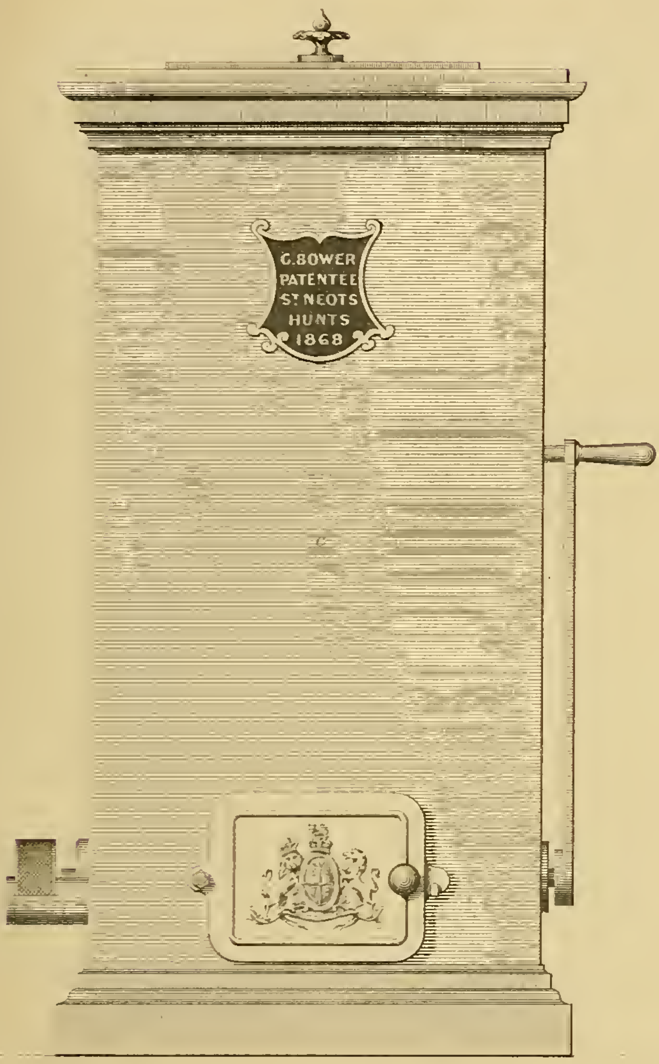


Fig. 3.

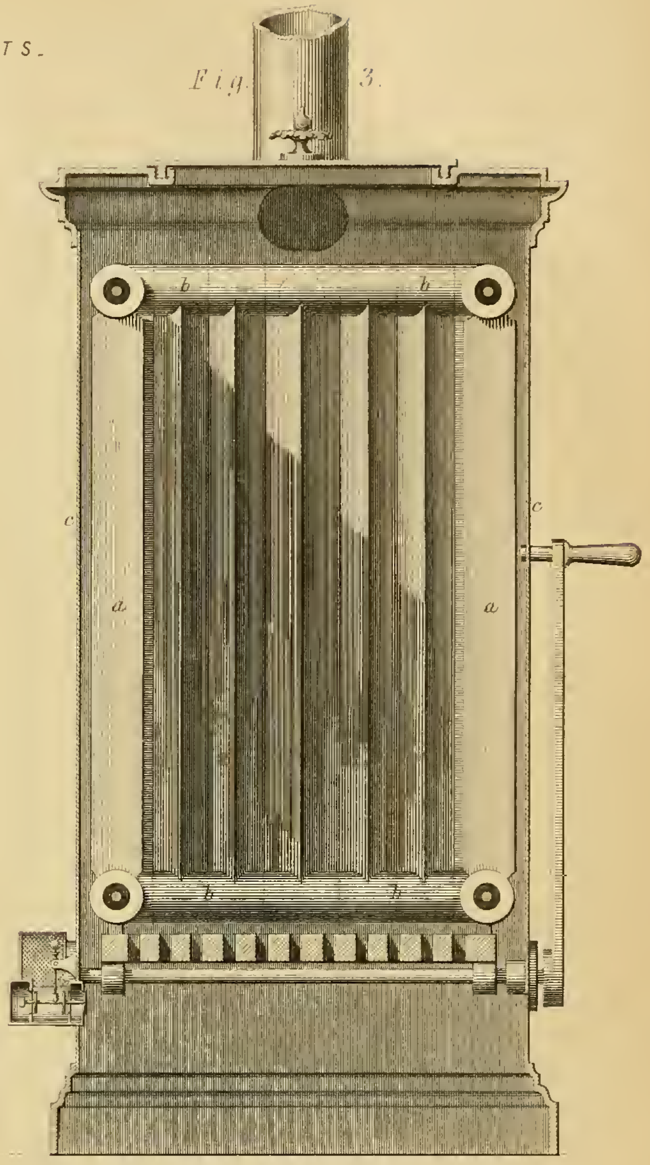


Fig. 2.

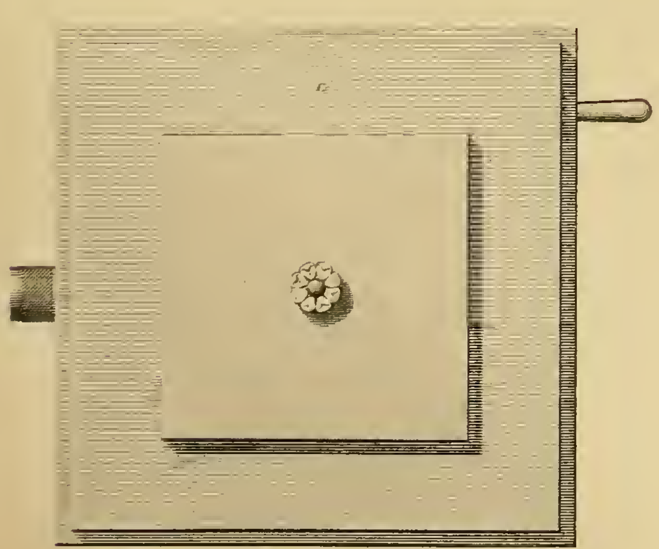
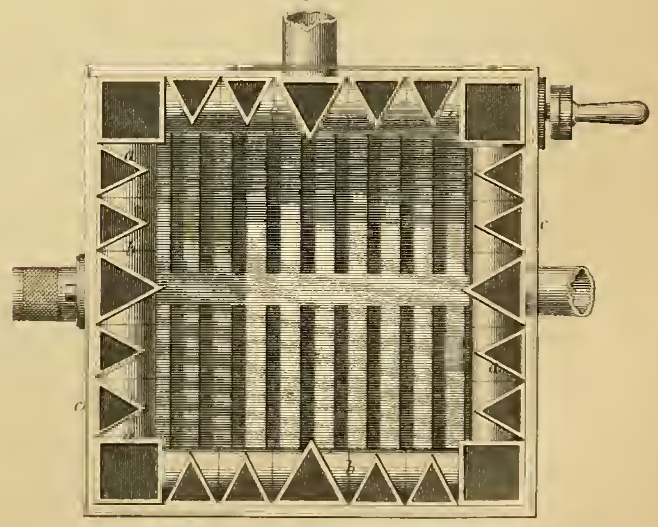


Fig. 4.



Patent Offices, 47 Lincolns Inn Fields London, and 166 Buchanan St Glasgow.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXXIII.

MALLEABLE CASTINGS.

We have said, we believe so far as ascertained facts are yet before us, that the change superinduced by annealing of the white brittle castings, whether in hæmatite, in chalk (as it is said is employed in the Austrian small-arms factories), in sand, or in any other powder, is not due, mainly if at all, to chemical alterations in the cast iron so operated upon, but to molecular changes produced in its constituent particles. What, then, are those changes, how are they produced, and how far is the hypothesis of their production sustained by other analogies known to metallurgic chemistry and physics? The great changes in the physical properties of metals producible by change of temperature alone are sufficiently familiar. From hardness and brittleness to malleability and toughness, as well as of the reverse, we have examples; and such changes may be caused either by *rapid* change of temperature, as in the *hardening* of steel and the *softening* of bell-metal (copper and tin) by quenching in water when red hot, or by *slow and gradual* change of temperature, as in the operations of annealing and tempering. There is, therefore, an *a priori* probability in the softening and malleableization of hard white cast iron by mere long-continued high temperature and gradual cooling; it is in accordance with known analogies, even were white cast iron a simple metal, or an alloy of two or three only.

On the other hand, let us look at some of the improbabilities which beset the view that the malleableization is due to a withdrawal of carbon by cementation, that it is, in fact, an approach made towards the conversion of the brittle white cast iron into *wrought iron* by reduction in percentage of carbon, and that thus some of the properties of wrought iron, such as malleability, toughness, &c., are conferred upon the so changed material.

According to Tunner, there exists but one unmistakably recognizable combination of iron and carbon, namely, that of which spiegeleisen (= Fe_4C) may be viewed as the type; all other sorts of crude iron are, he thinks, solutions of chemically pure iron in spiegeleisen, to which is to be added the fact, that in gray pig iron part of the carbon is merely diffused or suspended in the mass in the state of crystals of graphite. The difficulty anteriorly raised to such a view by Percy—namely, that spiegeleisen is in reality a compound of carbon with an alloy of iron and manganese, the latter being essential to the persistent combination of the carbon, for though "white pig iron may contain from 2·0 to 2·3 per cent. of carbon (while melted namely), yet it separates partially in cooling (*i.e.*, as graphite), and he has never known 5·0 per cent. contained in any white pig iron unless manganese was present" ("Metallurgy," p. 113)—is anticipated by Tunner thus:—"The electro-positive bodies," he says, "which the crude iron may contain, as manganese, aluminium, calcium, &c., represent a part of the iron, in the compound with carbon; and, on the other hand, a part of the carbon may be substituted by silicon (possibly even by sulphur and phosphorus)." So that, according to his views, crude pig iron, of whatever sort, may be represented by the following general rational formula, in which C_m and Si_n represent variable proportions of segregated (crystals of) carbon and silicon, and Fe_s the variable amount of pure iron in solution in the mass:—

$$\text{Crude pig iron} = \left\{\begin{array}{l} Fe_1 \\ Mn_4 \\ Al_4 \\ Ca_4 \\ Mg_4 \end{array}\right| \begin{array}{l} C \\ Si \\ S \\ P \end{array} \Bigg| + C_m + Si_n \Bigg| \; Fe_s.$$

We are not bound to accept the whole of these views, but they serve to clear the facts in the mind, when taken along with Karsten's more ancient views as to the forms of combination and suspension of the carbon. Very rapid cooling, as in the operation of chilling, compels the metal to assume the solid state without time for the segregation of the whole of the carbon. The whole of the latter may remain in combination after cooling, and that is the case where the original percentage of combined carbon is moderate or small; where it is large *some* carbon probably always is enabled to segregate and remain suspended in the still white mass, in crystals so minute and far divided as to be unseen by the naked eye, and leave the tint of the metallic fracture apparently unaltered. That this is so has been proved by the analyses by Bromeis of crude irons from Mägdesprung Works in the Erzgebirge, as follows:—

	Total Carbon.		Combined Carbon.		Diffused as Graphite.
White pig iron from blast furnace, .	3·018	......	2·518	......	0·500
Forge pig iron from refinery, . . .	3·458	.....	2·908	......	0·500

And according to that analyst, even spiegeleisen, containing but a slightly greater total percentage of carbon, contains some of it, and in about the same proportion, in the state of graphite. We may therefore be tolerably certain, that whether the Cumberland or Lancashire or other pig iron from which malleable castings are made, contains manganese or not, or whatsoever may be its constitution, that the intensely hard and white thin castings, when made from it, and prior to cementation, do already contain some microscopically small and diffused crystals of graphite.

What then can be more analogically probable than that, during the prolonged state of red heat and softness of these white castings, *more* of the combined carbon should segregate, and in doing so attach itself by aggregation to the already present microscopic crystals of graphite, and go to increase their volume, in accordance with the well-ascertained laws of forming crystals; just as in the dense and almost vapour-impenetrable clays of Sicily, at numerous *Suffione*, the nascent sulphate of lime constantly being formed in the mass by the vapour of sulphurous acid, further oxidized into sulphuric acid by the catalytic action of the dense but porous clay, forms crystals at first almost invisible, and very uniformly diffused, but which continually then grow in bulk by accretion to the mass of each nucleus and by mutual aggregation, until at last, pushing aside the intervening clay as if by mechanical movement, huge crystals of gypsum are formed in it, often of scores of pounds weight each.

This, as respects the carbon of the material, is in the writer's belief what happens in the annealing of the hard white castings which are to be thus made malleable castings. The view is supported by a very direct fact. A thickish mass of chilled and perfectly white casting, if exposed to a bright red heat for even two or three hours, has no longer the same fracture it had before. It is found to have lost some of its distinctive prismatic crystalline character, and its colour has become rather grayer than before, a change of colour which the lens shows to be due to microscopical grains of nearly uniformly diffused graphite. If such a piece be exposed to like heat for many days, whether not exposed to air at all freely, as when inclosed in brickwork, or when freely exposed to air, its texture becomes totally changed, perhaps even to the very centre; its fracture is then that of very open, porous, and weak light-gray iron, with a dull but extremely minute character of crystal. It has, in fact, become partially annealed, and it is not easy to discern any great differences between the result and that of the malleable-casting annealing process. The white chilled iron is no longer as brittle as it was before, and it has changed to gray iron which will readily receive marks from the pein of a hand hammer. The original casting from No. 4 Cumberland pig, or the like, *is a chilled casting*, owing to its slender substance and hence rapid cooling in the sand mould. What is more probable than that *it* becomes malleable, soft and tough, in the way we have indicated, and by the mere effect of the prolonged heat, just as the thicker chilled casting does?

It scarcely seems to have occurred to any of the numerous authors who have copied from each other the dictum that the production of malleable cast iron was due simply to decarburization, within how very narrow limits their theory is hemmed in. Percy says, and we believe quite correctly, in treating of the effects of various percentages of carbon on iron, that carbon present to the extent of from 0·20 to 0·25 per cent. characterizes steely wrought iron; with above 1·75 per cent. the wrought iron is scarcely forgeable and wont weld; and with 1·90 per cent. it is no longer malleable hot, and passes into cast iron ("Metallurgy," p. 113). In fact, 2·00 per cent. of carbon is a not uncommon proportion in hard gray or mottled pig of No. 4 or lower commercial numbers; and as some of this carbon, whenever the pig is cupola melted or even melted in open clay crucibles, is burnt out, and some more exuded in the sudden cooling of thin castings made even in sand, so in unannealed malleable castings we cannot expect to find more than about 1·25 per cent. or thereabouts of carbon in all states, whatever brand of pig iron, amongst those fitted for the purpose, may have been selected for use. There is probably in *no case*, therefore, more than about 1 per cent. of carbon to be viewed as removable by decarburization.

But the fact is, this even is greatly to overstate the case. Malleable castings all over the world are made from hæmatite pig iron, and always from No. 4 or lower numbers.

Now, according to Percy, although Cumberland No. 4 pig contains some manganese, 0·07, or nearly 1 per cent., its content of carbon is extremely low, being no more than 0·35 per cent. ("Metallurgy," p. 536). But wrought iron, when tough and malleable, &c., contains 0·25, or perhaps as little as 0·10, per cent. of carbon. It follows, therefore, that the actual amount of carbon removable by cementation cannot be more than from 0·10 to 0·25 per cent. in all, and there is no experimental proof whatever before us as yet that this much, or that any carbon at all, is actually removed by the annealing process.

We are fully alive to what may be specially argued by an author already committed to the decarburizing theory: that the less the amount of carbon proved to need removal, the greater the likelihood that it is so removed. A cogent remark, *provided* it had been first *proved* that any carbon at all were so removed, or could be removed, under *all* of the various and even contradictory conditions in which malleableization may and has been produced by annealing, *i.e.*, surrounded with oxidizing or with carbonating materials, hæmatite or carbonate of lime, or with neutrals, as sand.

But if the percentage of carbon in the white Cumberland pig be as low as 0·35, and if there be no decarburization, it may be asked, how then is the function of the annealing fulfilled? what does the annealing do that effects the change from white brittle pig to malleable cast iron? The reply would seem to be this:—By the sudden cooling of these thin castings they are *chilled*, and all or nearly all the carbon they contain is then *uniformly diffused* and in combination. By the prolonged heat of the annealing oven, all or nearly all that carbon is set free as graphite, and remains in *minute crystals*, also *uniformly diffused* in the castings. The final effect then of the malleable casting processes is to redistribute the graphite crystals, which are large and *not* uniformly distributed in the Cumberland or other pig iron, and to diffuse them in microscopic grains uniformly throughout the mass, and thus to confer flexibility upon it. On the other hand, assuming that the original pig contains 0·35 per cent. of carbon, and that it is decarburetted down to 0·25 or 0·20 in the annealing kiln, then the result *ought* to be, according to all siderotechnic analogy, *hard, steely* wrought iron, of very low malleability, *with some* brittleness, and of the high specific gravity and lustrous fracture of *wrought* iron. But what are the facts? The resulting material is very soft, very flexible, far from brittle; it will not weld, or with great difficulty; its fracture is dull, gray, and uniform, like that of all very fine-grained *cast* iron; and its specific gravity is decreased sensibly, in place of being increased.

We do not wish to push analogical arguments, nor indeed any others, here too far, in the absence of the only proper tests of analysis, but so far as our positive knowledge as yet leads us, everything seems to make against the decarburizing view.

But if the change be simply due to segregation in very minute crystals, with perfectly uniform diffusion of the crystals of graphite from the before-combined carbon, then is the physical change in the material—the malleableization—easy to comprehend. It is simply due to the presence everywhere of these slippery little crystals, or graphite scales, held together and in a microscopically reticulated net of wrought iron which forms the mass. And the recombination at a welding heat of some more or less of these crystals with the wrought-iron net, by reconverting more or less of it into the form of *cast* iron, is the reason why the malleable castings can scarcely be made to weld; while the interdiffusion of the graphite crystals, and existence of the wrought iron only as a divided net surrounding them, may be the reason why such castings can scarcely be much hardened by quenching in water, perfect uniformity of mass and absolute continuity of the mass of constituent crystals being conditions apparently necessary to the perfect hardening of steel.

All that we have here advanced will remain equally true, even though it be proved a fact that in all, or in certain cases, as in that of the ordinary cementation with hematite, decarburization does take place to a greater or less extent. It may be quite true that the brittle castings may lose carbon sometimes or always, in cementation, or the reverse may be true, and yet it remain a fact that the malleableization is simply a consequence of the rediffusion in a minute and uniform manner of the graphite crystals, and has nothing to do necessarily with the removal of any of the carbon. It may be even provably a fact, that certain castings, if made of iron too gray and rich in carbon, can *only* be rendered malleable by cementation with some decarburizing element, so as to remove the percentage of carbon down to a point such that no *great* scales of graphite shall be segregated, which, with their broad surfaces of crystalline contact and weakness, should prevent the malleability of the annealed mass. But that would only prove that if a pig iron too highly charged with carbon be employed for making malleable ware, we must decarburize it partially before we can make the annealing of any use.

It will probably occur to many to urge, that the American patent process of Professor Eaton, of Port Elizabeth, described in the American *Railway Review* some years ago—viz., by cementation with oxide of zinc in place of hæmatite, with a view to obtaining at once metallic zinc at the expense of the carbon removed from the iron and malleable castings—is in conflict with our view. We believe the patent in reality never was worked; it was a mere professor's patent based on theory, and that theory no better than that accepted from the books without question as to its want of foundation; and in any case, the amount of zinc thus reducible would be so ludicrously small that, as a manufacturing process, the patent would be worthless. But a further doubt is cast upon its bearing upon this question by the fact that calamine was, if we mistake not, the intended cementing material. Now this native carbonate of zinc, though it is by a strong red heat converted into oxide, must, just like the chalk, evolve carbonic acid in the first instance, and be as likely to add as to take away carbon from the red-hot cast iron.

But whether oxide of zinc will decarburize white cast iron or not, or whether Eaton's process has ever been tried, and if so, proved successful or the contrary, the facts leave untouched our view, which, so far as there is information before us up to the present, we have here urged, and venture, provisionally, to entertain, viz.:—

1. That no decarburization has ever yet been proved a necessary condition to the malleableization by cementation.

2. That malleableization depends not upon decarburization but upon a molecular change, viz., upon a change in the state of the carbon contained in the castings, due to the prolonged heating, so that cementation, in the strict sense of the word, is not necessary to the result.

3. That carburization or decarburization may occur during cementation (conducted in certain ways and with certain sorts of cast iron), but that either is a mere inseparable accident, and does not occur provided the quality of iron has been selected, in the first instance, as that known to be best for malleable castings.

We admit, however, most fully, that these questions can only be fully and finally settled before the balance of the analyst. The subject is not only technically important, but deeply interesting to the chemist and physicist, as well as to the practical metallurgist.

May we venture to hope that at least *some* of our systematic chemical or metallurgical authors will, before they publish more books copied one from the other, now condescend to settle experimentally the fundamental facts, which hitherto have been repeated as to this process without proof, and which we have ventured to dispute, or rather to show strong reason to doubt.—Ed.

THE PRESENT STATE OF THE MONT CENIS INTERNATIONAL RAILWAY TUNNEL.

Every metre that this grand work is pushed deeper into the bowels of the Alpine ridge increases the interest that every one, especially every engineer, must take in this vast enterprise—one the completion of which two or three years hence, along with the Suez Canal, will go far in rendering French and Italian engineering famous, and will together probably revolutionize the great lines of transit and traffic with the east and southern hemispheres within the next quarter century.

Mr. Fell's steep gradient mountain railway over the top of Mont Cenis has, from the very outset, been particularly unfortunate in its incidents and mishaps, and can scarcely, one may presume, within the limited time it can remain master of the position, in any sense be a paying concern. In a purely technical view, it may be and is probably a success. in this sense and to this extent, that it has demonstrated the practicability of working those very steep gradients and abrupt curves in safety (so far) over very hazardous ground, by the means provided; and the Fell system may be held as now demonstrably adapted to, or at least capable of being employed over, very steep mountain ranges, wherever these are in climates free from frost, or whose upper regions do not rest above the plane of perpetual snow, or very near it. It may therefore be applied to many mountain ranges in Europe, whose ridges do not range much above 6000 or 8000 feet, possibly with advantage. The disasters, now of two winters, on Mont Cenis, however, prove in our judgment, what we from the outset thought, that any attempt to construct a railway over Alpine slopes and crests, where more or less freely exposed to the effects of ice, snow, floods, avalanches, slips, and *eboulements*, at least upon the professedly cheap and unprotected method of Mr. Fell's line, must eventuate in nothing but a series of ruinous accidents to the line, and breaches of continuity and hence delay of traffic; in the end enough to prove, that the vast and terrible winter of these mountain solitudes cannot be coped with but at the cost of far heavier and more permanent and costly works than any engineer, not long habituated to practice in the high Alps, would probably deem necessary. That this is so, not only the disasters of the Mont Cenis Railway prove positively, but an examination of the magnificent and expensive works for securing the way of the Austrian line over the Brenner, which have so far proved adequate, proves negatively. Avalanches, floods, and huge masses of rolling and slipping mud, gravel, rock, and water together, passing across a line of railway, are not to be resisted by "half balk," or "mid rails," or by anything short of such masonry, such forms, such cover, such rock cuttings, &c., as shall give these moving masses their own way, and let them slip by, without their once being able to lay their iron hand upon the railway at all.

It was, no doubt, better practical knowledge, and wider acquaintance with all the mixed geological and climatic conditions and actualities of every severe winter in the Alps, that operated decisively upon the judgment of the engineers, who, with equal courage and foresight, settled upon a tunnel through the ridge of Mont Cenis, however long and costly, as yet really the best and cheapest mode of transit for a line of railway in the end; and we think facts have already, even before the tunnel is opened, endorsed the correctness of that judgment. Some of the most recently given facts as to this grand work, of an authentic character, we have derived from a very beautiful folio work just published simultaneously at Turin, Florence, Paris, and London, by Mons. A. L. Vialardi, a member of the Italian Alpine Club—an "Album Historique" of the piercing of the Alps, illustrated with excellent photographs of the tunnel mouths and works at both sides, some of the machinery both for compressing the air and for the rock-boring by its motive aid, and a section and map of the tunnel itself.

As we have in previous parts of this Journal given pretty full accounts of the tunnel itself, and ample accounts as to the design, &c., of the tunnelling machinery, we shall not say much more about these here. We must, however, be permitted to remark that the vindication which we published in this Journal, some years ago now, of the claims which the late Mr. Bartlett, C.E., had to be viewed as the illtreated and unrequited pioneer in mechanical rock-boring, has obviously not been ineffectual. In the historical sketch given by M. Vialardi of the origination and gradual improvement of the rock-boring machinery, as now here employed, the claim of Bartlett to have originated the rock-boring machinery of Mont Cenis is (for the first time, so far as we have observed) acknowledged in type, and in a foreign tongue.

The Mont Cenis Tunnel is 12,220 metres in length, from entrance to entrance, without a single shaft; one entrance being 1335·38 metres, and the other 1202·82 metres, above the Mediterranean mean level. The mountain crest loads the central part of the tunnel with a mass of rock of 1600 metres in depth.

The Italian government, it will be recollected, is to complete the tunnel at its own cost. When it shall have been completed, France is bound by treaty to contribute considerably to the cost; but as is obvious, the risk is all Italian. The risk *now*, however, is little more than whatever fear there may be that Italian finances may break down. In all other respects, the completion of the work is nearly as certain as that of an earth cutting upon the Great Western might be.

The work, it is said, is likely to be completed for greatly under the 65,000,000 of francs estimated for it by General Menabrea. There are about 3000 men of all classes employed upon the work, under the direction of a resident engineer in chief, an assistant engineer, a secretary, a telegraph officer, a doctor, and some lesser employés.

The ventilation of the two headings is maintained by the daily ingest of 14,320 cubic metres of air at a pressure of six atmospheres, equal to about 85,924 metres at barometric pressure. The perforating engines usually deliver at the headings by discharge about 600 cubic metres of fresh air per hour of the above. The gases developed by the breath of the men, and by powder explosion, are exhausted at the entrances through wooden trunks led along under the crown of the vault from the headings. The expansion of the air escaping from the perforators produces abundant coolness at the headings. The finished tunnel is all the year round at about —18° to —23° Centigrade. In the winter, when the cold on the mountain is at 17° or 18° Centigrade, the change of temperature on issuing from the tunnel at the "shifts" of hands is found very trying by the men.

The arch of the tunnel is 0·80 metres thick at the key, and is turned of stone, on centering in rings of about 6 metres in length each. Each metre running of tunnel requires 60 cubic metres of rock removal, and about 15 to 16 cubic metres of arch-lining masonry. At Bardoneche end the cubic metre of excavation and bringing to spoil costs 13 to 17 francs, at the Modane end 20 francs, arising from the difference in quality of rock chiefly, as will be recollected from our earlier accounts. The cubic metre of arch masonry costs from 30 to 34 francs in place. The lime is burnt at St. Michele for Modane, and at Casale for Bardoneche end. All expenses included, the cost per metre forward is, at the French end, 1300 francs, and at the Italian one 1100 francs. The whole tunnel is lighted at both ends by gas, the lights being 500 metres apart. The workmen light themselves by oil lamps of the usual character. The triangulation or geodetic direction of the line of the tunnel, both as to horizontal direction, and vertical, the latter with unequal elivities at either end, has been a most delicate and responsible duty, involving, upon so great a length without a single shaft, the most exquisite exactness of method and scrupulous care, in order that the headings shall meet when the happy day shall arrive that, through the first hole broken through, the approaching gangs of workers from French and Italian sides shall shake hands, and, as we hope, after the first ungovernable flush of honest enthusiasm shall have passed, thank the Disposer of events that so great an instrument for spreading civilization, and, let us add, for ultimately crushing out priestcraft and superstition in Italy, shall have been completed by their hands.

This delicate surveying work has been performed by Signori Capello and Borelli. The line was originally fixed from the basis of the great Sardinian Trigonometrical Survey by the aid of twenty-eight new triangles and by the observation of only eighty-six angles in all.

Eighty jumper holes are usually perforated in each heading at once, and charged with cartridges of from 2 to 3 hectogrammes of powder, and tamped with clay tempered plastic. They are fired in ring batches of twenty-five or thirty holes each, by means of Bickford fuse, burning at the rate of 0·6 inch per minute. Each complete batch of holes splits and shakes the rock to a depth of about 80 centimetres back from the face of the heading. For each metre forward from 96 to 100 jumper holes (besides the central *empty* hole of 10 centimetres diameter to give vent, as it is called, or freedom to the breaking face of rock) are required; these take from 43 to 45 kilogrammes of powder, and 210 metres running of Bickford fuse, and about 200 jumpers. So that by the time the work is done there will have been bored 1,220,000 jumper holes, which if all put together in one line would be about 616 *miles in outstretched length*, and there will have been exploded about 550 tons of powder, and about 900 miles of Bickford fuse burnt; there will also have been about two millions and a half of jumpers destroyed and sharpened. These figures are, however, only for the *heading proper*, the mere first advance; for the lateral enlargements which are necessary before completion of the arching these figures may be about multiplied by *five*. The powder and steel jumpers constitute the great bulk of the expense for materials.

The rocks already encountered, or to be yet met with, in going from the Modane end towards Bardoneche, are, according to the careful survey made by MM. Angelo Sismonda and Elie de Beaumont, micaceous sandstones interstratified with micaceous schists, quartz rock, anhydrite or anhydrous gypsum in mass being also found therein, dolomitic limestone, and schistose-crystalline limestone, with clay slates. All are of a hardness which those who have only seen the corresponding rocks in flat countries, like Great

Britain, can form but little notion of. In 1862, after the machinery had been got into steady march, it was calculated that, allowing for accidents, and for the wall of 400 metres of quartz rock to be got through, the work could be completed in from seven to eight years. The hardness of that quartz rock was such that little more than half a metre per day of twenty-four hours (all the works, we need scarcely say, go on day and night) could be pushed forward; that was all got through, however, in 1867, and now each heading advances about 2 metres per day, so that the work will be completed in 1871, and, we may assume, the line open for traffic in 1872, or say, three to four years hence.

On the 31st December last, 1867–68, when the last official statement was made, there had been pierced on the Bardoueche side 4724·50 metres, and on the Modane side 3122·15 metres forward, leaving at that date 4373·35 metres only to complete the perforation. Since then we may conclude that about nine months' work has been added, so that the remaining barrier of rock must be now (November, 1868) reduced to not much above 3300 metres, a length which, compared with the entire, seems small, but yet is considerably longer than the line of vision through a telescope, of the summit of Snowdon, seen from its nearest base, at Llanberris side or the opposite one.

Altogether this tunnel is a wonderful mark of human progress. At no anterior age—patriarchal, classic, "ages of faith," or what not—could it have been even attempted; tyranny and distrust and barbarism too much divided mankind, and literally did what is fabled of the builders of Babel, in confounding all combination for good. May the work prosper, with all that its accomplishment forebodes.—Ed.

A FEW NOTES ON PETROLEUM: ITS ORIGIN AND ITS DERIVATIVES.

The derivatives of petroleum, more or less applicable in the arts, seem to stretch out as though without end; and undoubtedly the end is far from being reached as yet. Some novel views, at least, have been broached as to the origin of petroleum, at least that of the United States. The origin of that was one of the subjects that came under the consideration of the United States National Academy of Science, at their meeting of this year, which was held at Northampton, Massachusetts. A paper was read by Mr. S. F. Peckham, in which he regarded petroleum as the normal product of the decomposition of marine animal or vegetable organisms, but chiefly the former, and the various solid bitumens and asphalts as products of a subsequent decomposition of the liquid hydrocarbon. The smallness of amount of nitrogen present in the Pennsylvanian oils, he said, does not make their origin from plants impossible; but when one comes to the later oils of California, so much nitrogen is present as to render the decomposition of the petroleum analogous to putrefaction of animal flesh. Theoretical formulæ, showing how stearic acid and the stearate and oleate of glycerine might easily be changed into the oils or hydrocarbons, were presented. Proteine, when subjected to decomposition, submerged in water, would give rise to a nitro-hydrocarbon like the Californian oils. At one locality in California the boring penetrated several feet through a mass of fossil bones, saturated with the fluid. The liquid retained for several days the cellular structure of bone, but finally lost its organic structure by exposure. If it be objected that a petroleum derived from animals ought to contain phosphorus and sulphur, it may be clearly shown that the aqueous conditions of decomposition will remove both these elements as soluble compounds, and scarcely any traces of them be left behind. Petroleum was hence divided into two classes: the first contains paraffine, and forms asphaltum by inspissation, or absorption of oxygen from the air; and the second contains no paraffine, and forms asphaltum by decomposition. The first are the liquids from Oil Creek, and the second are well represented by the petroleums of Southern California. The latter are not held in natural reservoirs of liquid, as in Pennsylvania. The strata are tilted at every angle, and the fissures are of limited extent, so that the oil is really kept in place by capillary attraction. The wells bored there have varied from 50 feet to 400 feet in depth of the solid materials of the oil beds.

This singular theory, if theory it may be called as yet, scarcely can be said to "go upon four legs." It is extremely unlikely that the sulphur and phosphorus of animal origin would be removed in a soluble form; but if so, complete oxidation must first have taken place. Iron in some of its saline forms is almost always present in the superficial formations, and its hydrous oxides are abundant in these. The sulphur then, if any such enormous masses of animal remains were entombed and decomposed slowly, as would alone suffice for the production of the Californian oil seams, would produce large quantities of iron pyrites, as is sufficiently well known. But were that so, it could scarcely fail to have made its presence evident in the crude oils, here and there. It, further, is by no means clear that the phosphorus would be all oxidated, or if oxidated, that at a later stage it might not lose its oxygen again to the slowly oxidating hydrocarbons, and so give rise to phosphuretted hydrogen in the inflammable gases accompanying the oils. Above all, upon what sound geological basis are we to rest so formidable an hypothesis as this theory demands, in the almost inconceivable mass of animal remains drawn into one grave, or locality at least?

The mere conjuring with possible formulæ, to show that from animal remains nitrogenous oils may be evolved on paper, goes but a short way to proving that such metamorphoses ever have taken place. Let us first catch the fish before beginning the theory of cooking it—prove the existence of mountainous masses of animal remains anywhere, in any formation, at any epoch of our planet, and we are ready to go on. All the thickly set mammoth and elephant bones in the vast bone shoal of the German Ocean, one of the greatest nests of animal remains we know of, all those remains in the lias beds, those of Siberia, of Georgia and Alabama, and the fish of Monte Bolca thrown in, would go but a small way towards producing a supply for one single oil well. The origin and nature of the production of nitrogenous mineral oils is yet to seek, we believe.

Amongst the derivatives in the second degree, from this unexhausted mine of discovery and of wealth, petroleum, is picric or carbazotic acid ($HO, C_{12} H_2 (NO_4)_3O$), which, as we recently explained in an article on carbazotic gunpowder, though at first obtained from indigo, has for some time had its most abundant source in carbolic acid, itself a product of petroleum.

The powerful colouring properties of picric acid were early known, and its strong affinity for animal matter, which it dyes—as silk, for example—of various orange and yellow colours of great magnificence. Since picric acid has become cheap, it has come to be employed as a dye, and recently as one for silk and woollen hosiery for the feet, in the shape of stockings and socks. Within the present month (September, 1868), several surgeons in London have announced in the public papers their independent observations, that the picric acid dye in such hose is acted upon in some as yet unknown way by the perspiration of the feet, where the latter is kept in contact with the dyed stockings and with the foot, by the pressure of the shoe or boot, and that the result is some compound which acts as a morbid poison upon the skin of the foot. Its effects are stated to consist in a rapidly setting in itchiness, redness, pustular eruption, with erysipelitan inflammation of the skin of the foot where covered by the shoe (not above it), and accompanied by great constitutional irritation and symptoms of the absorption of a morbid poison. The result seems beyond question as to evidence, and is as singular as unexpected; the nature of the body formed by the reaction of the skin secretions remains to be examined by the organic chemist, before it can be pronounced with certainty whether the dye itself be poisonous *per se*, or only after such reaction. In any event, its use should be abandoned unless it can be more firmly fixed in the fabric; for even in house hangings, curtains, &c., particles swept off and taken by breathing into the throat and lung passages, may prove a more formidable domestic poison than even the much and deservedly decried arsenical room papers.

It should be borne in mind, however, that picric acid has been more or less employed as a dye for many years past; whether in the state of its alkaline combinations or not, we are not aware, nor whether this be its first application to socks, &c., which imbibe, certainly, some of the most gross perspiration emanating from the human body, and that, therefore, the most likely to react in some way upon the material of the dye.

The fact is, however, that all the aniline dyes are more or less poisonous—dinitro-aniline, nitro-phenylenediamine, strongly so; and two well-known dyes, the Victoria orange (chrysaniline) and Manchester yellow (chloroxynapthalic acid), probably not less so.

But poisonous yellow and orange dyes capable of irritating and poisoning the skin are not confined to these. Orpiment and realgar, the sulphide and bisulphide of arsenic, have been by no means uncommonly employed as dyes for silk and wool; and the injurious experiences of some who have applied arsenical depilatories to the skin, sufficiently prove that such dyes, very loosely fixed in the fabrics, would be likely to produce the effects described.—Ed.

THE MARITIME EXHIBITION OF THIS YEAR AT HAVRE, FRANCE.

This exhibition, now drawing to its close, of which so much was spoken and so much anticipated at the beginning of the year, has proved itself to all intents and purposes a total failure—a failure as respects the right and legitimate objects of every industrial exhibition, and equally so as respects those illegitimate and noxious aims and objects which have now got to cling like *rémoras* to everything of the sort; namely, all that strives simply at shopkeeping, money-making, by "improving the occasion" for bargains, traffic, and amusements, to say nothing of the small place-hunting and notoriety-mongering that belongs to "arrangers," and *exposants*, and adjudicators, and the rest who make up the now inevitable, but in great part undesirable, *personnel* of these periodical displays. The causes of this failure have been many and various. He must have been a bold man who may have predicted success for any provincial French exhibition, coming so near in time and place to that of 1867 in Paris. Yet a *genuine maritime* exhibition, one to be confined strictly and honestly to such things as are directly and solely concerned in man's mastery over the great deep, and the things innumerable that are therein, and which he takes from it, and that *might* include (as the sea is, in the words of an ancient Norse ballad, "trade's plain") all those objects which "sea-passing ships" bring to or from the great port at which the exhibition was to be held, that port being, not quite without just ground, called by Frenchmen "the Liverpool of France." All this looks, and is, so symmetric, so reasonable, so reflective of great interests and ventures of all sorts, that some would have said, Yes, it may be a success; it is a thing new in idea, definite, and important. A wise man would have added, however, If it is to be a success, it can only be so by your rigidly adhering to your plan; let that which you profess shall be a maritime exhibition be so exclusively and in very truth; should it prove small, as probably it will, never mind that; don't attempt to give it a fictitious magnitude and unreal importance and size by sinking the truth and enlarging what professes to be a maritime exhibition into an indefinite mass of glittering objects, which belong to nothing and nowhere, land or sea, in particular, and which will thus at once convert your maritime exhibition into nothing better than a paltry, little, provincial imitation of the *Exposition Universelle* of last year, to say nothing of making it in its very name and actuality a standing lie. Unfortunately that, wittingly or unwittingly (and we believe it was in a great degree the latter), was just what was done. The programme of the Exposition consisted of five groups in all, omitting the last of these groups, which really constitutes the very *bathos* of mean absurdity, as a group in connection with any exhibition, consisting, with the one exception of the marine aquarium, a thing quite in its place and of which more anon, of *concours et experiences*, *fêtes maritimes*, *congrès maritime et conferences*, and above all things in the world for a maritime exhibition, of *horticulture!*

Amongst the four other groups were two, so loosely framed and entitled, so utterly devoid of precise idea or limit, viz., the Groups III. and IV.—Exportation and Importation—that in fact anything whatsoever, it mattered not what, so as it could be brought into a country or out of one, might be admitted. The Great Pyramid would possibly have been excluded as outside that condition, and Strasburg Cathedral, as not being transportable without danger, like a confectioner's supper-table sugar basket, of being dislocated in the transit; but enough might be got in under these two heads to fill and furbish out not only the entire 12½ acres or thereabouts which the exhibition covers, but even the whole area of Havre and of its docks. It is not unlikely that the looseness of classification was merely the result of quite honest want of foresight, but once perpetrated, it has borne its fruit. Nothing that was offered could in fact be, on any assignable principle, excluded, and so we find a large portion of the so-called maritime exhibition has but the indirectest relations to anything maritime or seaward; we come at all points across such strange maritime commodities as Paris bonnets and millinery, Brussels lace shawls, perfumery, porcelain, *toys* (*bimbeloterie*), petrifactions and incrustations, safes and strong boxes, balances of precision, fire-engines, carriages and horses, egg testers, bug destroyers, cards for power-looms, sewing machines, marking ink, music and musical instruments, printing and lithography, and hundreds of other things as *bizarre*, to say nothing of the *annexe des beaux arts*, of which we may say, that one single object of the higher class of fine art we were unable to discover in its very bric-a-brac collection.

Now, all these, and everything else, became "maritime" as soon as they were admitted, in something of the same way that the ladder of exposition is woven in "the house that Jack built:—" This is the Havre maritime exhibition; this is the sort of ship that comes to Havre and leaves it; this is the sort of "saddlery, harness, and brushes," that are exported in the ships that leave the port, and are seen in the maritime exhibition; this is the Brussels shawl, which might be bought, and being bought, might be worn, by a lady who might have a cabin in the ship to leave the port, that is seen in the maritime exhibition, and so on. But is all that truthful, dignified, or worthy of Havre or of France? The spasmodic efforts made by some of the greater exhibitors to hook themselves on to something maritime was amusing enough. Thus, one of the great exhibitors of French gold and silver plated ware, of which there was a really fine and profuse display, set forth in large letters in the very forefront, upon a tea and coffee breakfast service, the inscription, "Type of the services supplied to the steam-ships of the Messageries Imperial;" but for all that the immense mass of "land lubbers'" plated ware refused to "suffer a sea change," and would still look like what it was, the contents of a big silversmith's shop on the Boulevards at Paris. All this, however, might possibly have been forgotten or ignored had the parts of the exhibition proper, the groups of navigation, ships, their forms and rigs, marine findings, means for propulsion, and so forth, been adequate to the occasion. Unfortunately, we cannot say that they were at all so. Nor is that to be wondered at; rather it would have been wonderful had it been otherwise. Almost everything that relates to the sea, and to going down to it in ships, or coming up from it again, is characteristically bulky and ponderous, therefore very expensive to transport; and it was not to be supposed that any of the great French, still less of foreign, naval constructors, marine-engine builders, iron-masters concerned with iron-ship material, &c., &c., would, after 1867 at Paris, again go to the large and objectless cost of exhibiting at Havre. A few well-known names show themselves, such as Mazeline, of Havre, who exhibits well-made iron masts and yards, and Napier & Co., Glasgow, who send various models of ships, and some others; but we are obliged to say, that throughout the exhibition, in those classes where we might have hoped to find objects properly maritime, and interesting by either their novelty or excellence, we failed to discover such. It would be easy to slope off this harsh-sounding but not ill-naturedly intended judgment by filling pages with the usual stereotyped style of the journals of such occasions. Messrs. So-and-so exhibit such and such of great excellence; Mr. M., his well-known manufactures; MM. N. again support their well-known reputation: all that, at least, might be repeated here of Havre; but *cui bono?* Is not every sensible reader sick of it? as sick as if compelled to read an old directory. The number of exhibitors appears by the catalogue, which is a small octavo volume of about 400 pages, including advertisements, to be between 5000 and 6000; many of these contribute, of course, but very small objects. The exhibition ground is a nearly rectangular area, and the 12½ acres are surrounded by a plain single-spanned timber shed, of some 50 feet, perhaps, in width, running all round, with several cross annexes of no great magnitude. Along the inner wooden wall of this shed runs a continuous timber verandah on posts, in which are shops, and we fear we must call them literal "booths," for the sale of toys, *bon-bons*, and a thousand and one small wares, as well as for coffee and liquors. The interior area is laid out as a sort of park or garden, and contains at a few spots some pretty bits of parterre. In it are a concert-hall, sheds, and green-houses, for horticultural displays, many large objects, one large and commodious café and dining establishment, and, upon a small scale, much of the *bizarrerie* that made the park of the Champ de Mars so strange. In the centre is the great marine, *i.e.*, sea-water aquarium, perhaps the best planned and best carried out thing in the whole exhibition. A block rises from the ground abruptly, intended to represent the Island of Staffa upon a reduced scale; the ground of the garden being the supposed sea level. The vertical basaltic columns, thrusting up their thick cap of loose material upon their upper ends, spring out of the ground. They might have been better coloured; coal tar and some dark ochre over cement scarcely give the genuine rusty, greenish tint of sea-weathered basalt. Fingal's cave is supposed to be at one end, and affords the entrance to the interior. Once inside, after a slight descent, and we are in a large, though not lofty, irregularly rectangular cavernous sort of gloomy chamber, the whole light of which comes in through the plate-glass cisterns, which are arranged at close intervals all round, and filled with sea-water, constantly renewed. It is probably the largest scale upon which a marine aquarium has ever been constructed, and forms not only a highly interesting, but a very instructive exhibition.

To ourselves, decidedly the most important and instructive object we witnessed in the way of screw or oblique propulsion, in the whole "Exposition," was the large ray fish, as he moved with unapproachable celerity and grace, in search of prey for his fearfully ugly mouth, by the flexed movements, not alone of his fins, but of his entire flat body, bent and unbent into spiral curves, of the nature of those of our screw propellers, but to the exquisite perfection of whose surface forms, both for propulsion and for clearance, no propeller of man's handiwork has ever yet approached. We have little doubt but that by fixing these curves by means of instantaneous photography, and subsequent examination of the forms, &c., some valuable light might be thrown upon the improvement of our mechanical propulsion.

The oyster fisheries of France have here shown their methods of propagating these delicious animals. We cannot go through the train of cisterns, however; it belongs to the zoologist rather than to the practical mechanic. Some wonderful fish and molluscs from the French tropical colonies are to be seen; but the palace was constructed on too large a scale for the aquatic inmates that could be collected, so as to have every cistern a world with different inhabitants, and so it has happened that several of these present duplicate specimens; thus there are soles, and dog-fish, and bream, and so forth, innumerable, and in many places.

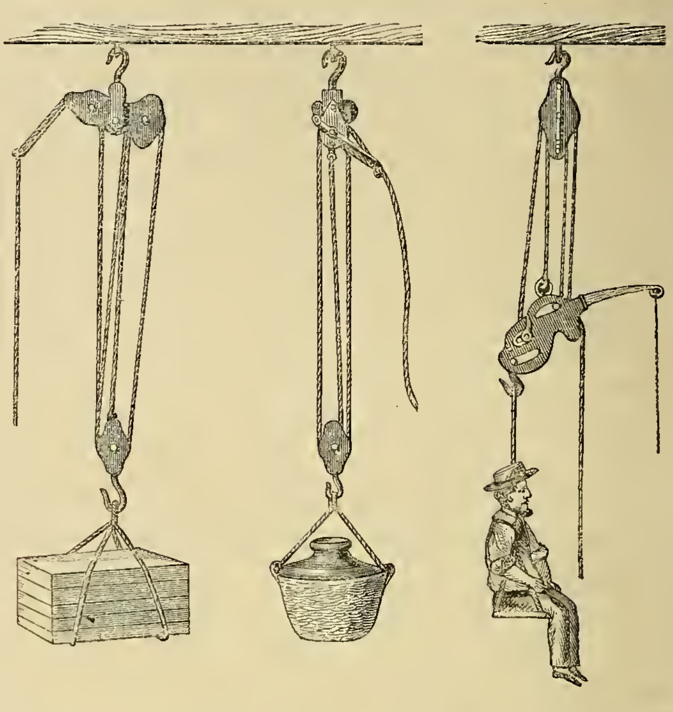
Almost the only objects in the machinery departments that attracted special notice from us were the following:—A large casting for a marine-engine condenser, sent by Keten Frères, of Blanzy des Arras, is a heavy and a fine piece of moulders' drysand work, and said to have been moulded from slips, templates, and "partial patterns"—*i.e.*, without any general pattern. Skinner's patent steering gear, represented at Havre by M. Sansom, Quai d'Orleans, is exhibited at full size, and seemed the best thing in its department; though we are by no means certain that it is the best possible steering gear for large rudders, or that the best steering gear has yet been contrived at all. No steering gear, no more than any crane, can be said to be perfect, which concentrates a tremendous mechanical strain upon some *one* holding point of the gear. That is the fault of the otherwise convenient plan of crane consisting simply of a worm-wheel and endless screw. The *palans de sureté*, or blocks which grip the tackle-fall by a system of *encliquetage*, so that until that is released by pulling a cord, the load cannot fall by overhauling the blocks, exhibited by M. Meunier, *constructeur*, of 15 Rue de Trois Bornes, Paris, of which we give some little figures beneath, have a good deal of merit in their simplicity and effectiveness, and we expect will ultimately make their way to a greatly increased number of applications. The general principles of these will be easily understood from inspection of the figures. The clip piece is on all the plans of construction, for there are several, so arranged that it grips automatically the rope or cord between it and the groove of the sheave, and though permitting the rope to pass freely when being hauled upon to raise the load, will not let it run back until the clip be removed by pulling the cord, or by one or other of the other methods devised. These blocks were, however, exhibited at Paris in 1867, and received honourable mention, though very little notice besides.

There is a large supply of exhibitors of "charlatan" paints and soaps for avowedly preventing the corrosion and fouling of iron ships. Such a paint remains to be discovered, or rather, to write more correctly, is not possible.

Amongst minor objects, certainly that which was newest to our observation and of most interest were the artificial or imitation diamonds in Group II., Class 8, formed, not as the usual Paris diamond, of a potass flint glass, richly charged with oxide of lead, but here of a like glass, in which the oxide of the new metal thallium (of which Mr. Crookes and M. Lamé were the discoverers) is substituted for the oxide of lead. The new glass, which, it is stated in some of the French and German journals, presents the likelihood of being of great value for optical purposes, is denser, harder, more lustrous, and with a higher refractive power, than any other glass yet produced. The so-called diamonds formed of it certainly exceed in colour, lustre, and brilliancy those of the older material.

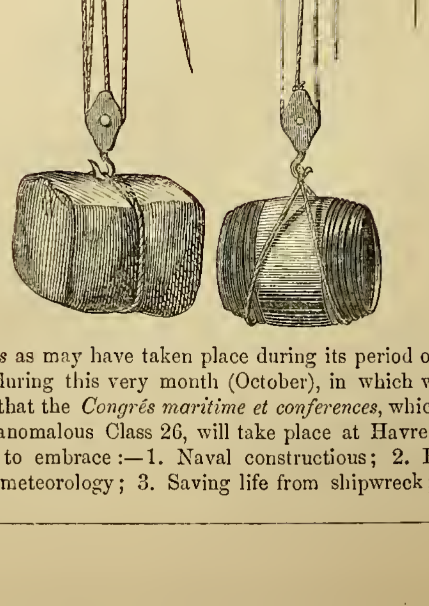
Coal owners having steam coal and *briquettes* for steam marine fuel to make a market of, appear in considerable force, from France, Belgium, England, Wales, and Scotland. Their displays are some of the most *real* in the exhibition, viewed as a maritime one.

There are a great many steam boilers of small types (Hubert's, of Paris, vertical cylinder shell with movable vertical tubes, amongst the number), some models of marine boilers, and drawings, but no huge realities as at Paris.



As to the regattas, the bull fights, the hippodrome, the races, and so forth, we shall say nothing, as the best we can say of them.

It is promised that a report will be printed at the closing of the exhibition, giving an account of the *jugements* and of such experiments and *concours* as may have taken place during its period of being open. Some time during this very month (October), in which we write, it is announced that the *Congrés maritime et conferences*, which are to constitute the anomalous Class 26, will take place at Havre. These are as subjects to embrace:—1. Naval constructions; 2. Hydrography, navigation, meteorology; 3. Saving life from shipwreck; 4. Interna-



tional commerce; 5. Fishing and agriculture! 6. Hygiene and nautical medicine. Whether a report of the proceedings will be given or not is not said; it will probably depend upon the state of the funds of the exhibition, and from its past history, and the want of almost any interest in it, which appears to prevail in France as well as in the rest of Europe, we fear these cannot be very flourishing.

Nothing more decisively marks the complete failure this affair has been, than the persistent declension of the emperor or any of his immediate family to visit it, though it is said he was, as he is always, anxious to promote its welfare on public grounds, and was earnestly besought to shed the sunshine of his presence upon its gloomy prospects. Besides those grounds for failure which we have already noticed, there was this unfortunate circumstance that the opening was greatly delayed. It was late in June before the exhibition was anything more than a long set of custom-house sheds, full of chaos. Some of the best of the year was gone thus, before it was in a position to receive visitors, and hear the chink of franc pieces at the *tournequets*.

Yet Havre itself, with more than 50,000 inhabitants, not 150 miles from Paris, nor more from London, is itself well worthy of a visit, though neither a manufacturing nor a very old town. It is, in fact, little more than 300 years old. In Louis XII.'s time (1509) it was no more than two timber jetties and a small fort. Francis I. built the strange great old circular tower, with its surface of stone covered over with hemispheres and projecting cubes, as if studded with bombs and gigantic dice, which until lately was one of the most prominent objects and substantive defences of the old harbour; and in the reigns of Louis XIII. and XIV. the citadel and fortifications were completed, which rendered Havre the dirty, crowded, unprogressive place that it was up to the end of Louis Philippe's time. Since that all has been changed; under the vigorous sceptre of the emperor the ditches and ramparts, and the citadel bodily, have disappeared, and the magnificent commercial basins and docks now executed have occupied a large portion of their sites, while wide streets and boulevards have spread over the remainder, except a large space where once was the citadel, and where a truly imperial floating dock with 90 or 100 foot entrance gates and nearly 30 feet depth of water on the cills (the tides, owing to the estuary "bore," rise from 20 to 30 feet), is now in progress of completion, and is a very instructive example of dock engineering on a very bad bottom. Besides these, there is not much to see in the town, except the *musée* of every French *chef lieu*, and the library with its seated statues of two great Havre men, Bernardin de St. Pierre and Casimir Delavigne, in front of it. There is a noble pair of iron sheer legs at one of the basins, by Mazeline, and the activity of the place, whose basins hold 500 ships afloat, and whose customs annually reach near two millions sterling, is striking even to an English eye. There are no very striking manufactures; rope, sugar-baking, sulphuric acid, pottery ware, and a little lace and carved ivory as at Dieppe, nearly exhaust the list, except the ship yards and iron foundries, of which there are several upon a very fine scale. One cause for want of visitors to the exhibition, notwithstanding all these civic attractions, has no doubt been the badness of the hotels. The very best of these are located in old frowzy, wainscotted houses, with large but gloomy and inconvenient bedrooms, and, for France, remarkably poor attendance, and worst of all, with a decided need of one of the "exhibits" of the Exposition, viz., the *poudre insecticide*. It is marvellous that a port at which so many ocean steamers depart and arrive should not be better provided with hotels. That called the Frascati (on the shore—beach there is in fact none, or none free to the public—which is that which alone makes Havre one of the bathing places of France), is shabby, mean, and comfortless. There could be no better speculation than to build a grand railway hotel upon or facing the sea, and a mile or so to the north-east of Frascati, and connect it by branch from the *Chemin de Fer de l'Est*, with the steam basins and the terminus of Havre. That would at once raise Havre to the real position of a good bathing place, and take all the hotel traffic except that of the bagmen and other "commercials," who might still find it necessary to inhabit the centre of the town.

However, with all its shortcomings, it was well meant, and in nothing material was it discreditable to the great and thriving emporium and port that projected it, and although we have not been able honestly to say much in its praise, nor anything before this period, it was but fitting that some notice should be put on record in the pages of the *Practical Mechanic's Journal* of that which has been, for better or for worse, the industrial feature of a dull year—the Havre Exhibition.—Ed.

CROS' AUTOGRAPHIC TELEGRAPH.

The object of Mr. Cros' improved telegraph, which was exhibited at the Paris Exhibition, is to correct the synchronism of the apparatus by successive stops, and to obtain these stops without the necessity for arresting the motion of the driving mechanism, and to avoid shocks. To effect this he has had recourse to a system of gearing with a satellite wheel, arranged in the following manner. On the driving shaft two loose wheels are disposed side by side on two sockets, but a short distance the one from the other. One of these wheels is provided, in addition to the ordinary teeth, with a flange having internal teeth formed therein; the other wheel carries on a spindle a small satellite wheel which gears into the internal teeth of the other wheel, and also into a wheel of the same diameter fixed on the driving shaft, on which are placed the two loose wheels. The circumferential teeth of the first of these wheels, which we shall call the flange wheel, are in gear with a system of escapement actuated by electro-magnetic power, whilst the second wheel, which carries the satellite wheel, imparts motion direct to a disc which has six notches formed therein, and is disposed like the notch wheel of a clock beneath the escapement mechanism referred to. This disc performs the same function as the correcting wheel in Hughes' apparatus and the correcting apparatus in that of Desgoffe. The electro-magnetic apparatus, which acts at the same time on the escapement and on the correcting disc, consists of a rocking lever, jointed at one end and carrying two stops. One of these stops arrests the motion of the escapement wheel when the rocking lever is raised. the other takes into one or other of the notches of the disc when the lever is lowered. Now, the depression or elevation of this rocking lever is dependent upon the operation of an electro-magnet, which is put in action by a local current supplied thereto by a circular interrupter, placed on the shaft which actuates the escapement wheel. The circuit, however, in which this electro-magnet is interposed is so arranged that it is the line current which determines its action; and this action is such that if the correcting disc is in advance of that of the opposite station, this advance movement is immediately corrected at the moment when the rocking lever is raised, as the two discs always start at the same time. The operation of this system will now be easily understood. At the moment when the two apparatus are started at the stations the correcting discs are stopped at both stations by the passage of a local current through the electro-magnetic system. The result of this is that the escapements of the driving mechanisms are disengaged, and the flange wheels operate under the influence of their satellite wheel, the latter being maintained in a fixed position in consequence of the stoppage of the correcting discs. During this time the circular interrupter of the local current has turned, the current is then interrupted and the rocking lever is raised, thereby stopping the escapement. The flange wheel is then stopped, and the satellite wheel being forced to turn, rotates round the internal teeth of the flange wheel, thereby transmitting motion to the wheel which carries it, and which actuates the corresponding correcting disc. The latter advances until the rocking lever in falling enters the next notch, so as to arrest its motion and disengage the wheel work of the flange wheel, and so on in succession.

In order to explain by what means the synchronical operation of the apparatus is continually corrected, we should add that the rocking lever, in its oscillating motion, and in coming in contact with two screw stops, constitutes at the same time a double interrupter, which by means of the lower screw puts the line in contact with the correcting electro-magnet, and by the upper screw with the tracing point of the autographic system. We should also observe that the battery which acts on the correcting mechanism is entirely independent of that which acts on the telegraphic system; the communication is also so established that the two currents would be in opposite directions if they traversed the line. The current, moreover, which influences the correcting electro-magnets passes to the station through a relay, the armature of which is polarized by a permanent magnet. The following effects are produced:—The current starting from the battery to the correcting mechanism proceeds direct to the transmitting electro-magnet, and thence to the line by the circular interrupter and the lower screw of the rocking lever. This, however, only takes place when the correcting disc is stopped. After having traversed the line it arrives at the rocking lever of the receiving apparatus, and thence by the lower screw to the corresponding relay, which sends through the electro-magnet of the apparatus a local current passing through the circular interrupter. The result of this is that the interruptions of the two currents in both apparatus are dependent the one on the other; for if we suppose that the current in the receiving apparatus is interrupted before that of the transmitting apparatus, the rocking lever of the first apparatus in rising breaks the circuit, and renders inactive the electro-magnet of the receiving apparatus. Thus, in any case, the armatures of the two electro-magnets are attracted at both stations simultaneously, and consequently the motions of the two discs always take place at the same time. In order to diminish the differences of motion during each one-sixth revolution of the discs, a regulator on Foucault's system is applied to the driving mechanism of each apparatus. There is nothing peculiar in the telegraphic system *proper*. It is composed, as in Backwell's apparatus, of a metal cylinder, which has a progressive motion imparted to it along its axis by an endless screw, and the tracing point carried in a bearing attached to a handle has an intermittent motion round this cylinder corresponding to each disengagement of the correcting disc. Now, as the motion of the discs is perfectly synchronal at the two stations, that of the tracing points must be also synchronal. The progress of the current across this part of the apparatus will be readily understood; at the moment when the discs are in motion the rocking levers have established the contact between the line and the tracing points, so that the current specially destined for this purpose has only to be put in communication with the transmitting cylinder at the time that the receiving cylinder communicates with earth, in order that the transmission may be freely made. It is scarcely necessary to add that, by the use of a double contact interrupter, the transmitting instrument may be transformed into a receiving instrument, and *vice versa*. We translate the above from the "Etudes sur l'Exposition de 1867."

BREAD-MAKING.

We translate the following interesting article on bread-making, by Mons. Henri Villain, from the "Etudes sur l'Exposition de 1867":—

Bread-making is the final object of the production and grinding of wheat, which grain only acquires its importance from the fact that the flour produced from it is convertible into bread, the chief article of food of the whole European populations. It was formerly made in families with more or less skill, the wheat being first sent to a neighbouring mill to be ground; but this practice is not now carried out to any considerable extent, for even in the country there are few villages where there is not one or more bakers, according to the extent of the population.

Bread is the result of the baking of a paste made of water and corn flour. The flour most employed is wheat flour; but the other cereal grasses, as rye, barley, oats, &c., also yield flour capable of being used in the manufacture of bread. Rye is still used to some extent in the French provinces, and barley is also much employed in Germany and in Spain. Oat flour produces bread of a very inferior quality.

The theory of bread-making has for some years been perfectly elucidated, thanks to the labours of Messrs. Boussingault, Payen, Péligot, Millon, Reiset, Barral, Mége-Mowriès, who were themselves aided by the previous researches of Proust, Davy, Vauquelin, Einhoff, Braconnot, and Vogel. By availing themselves of the results obtained by the *savants*, several distinguished practicians devoted to the art of bread-making attempted the use of mechanical appliances in the manufacture, which up to that time had only been carried on by manual labour, and their efforts have proved so successful that the manufacture of bread now stands on a par with other manufactures.

We find in wheat flour (besides water, which varies in proportion, according to the species of grain, from 12 to 18 per cent.) the following constituent parts:—

	Per Cent
1st, Azotic matters, insoluble in water, of which gluten is the type, .	12 to 13
2nd, Azotic matters, soluble in water, of which albumen is the type, .	2
3rd, Non-azotic insoluble matters (starch 60 per cent., fatty matter 1 per cent., and a little cellulose?)	61 to 62
4th, Soluble non-azotic matters (dextrine, and a little of a sweet substance), ...	8
5th, Mineral substances (phosphate of lime and of magnesia, salts of potash, soda, silica, &c.), ...	1 to 2

One essential condition, in order that all the elements of the flour may contribute to our nourishment, is, that they be all capable of being assimilated, or, in other words, of becoming soluble. The object in view in bread-making is to effect this dissolution by acting chiefly on the gluten and starch. The grains of starch are swollen by the absorption of water, and burst in the operation of baking. The gluten, which is of a plastic nature, is expanded by fermentation, and occupies a large surface, so as to facilitate the action of the juices of the stomach upon it. The manufacture of bread thus comprises three distinct operations, viz., absorption, which is effected by kneading; fermentation, to leaven the paste; and baking.

The non-azotic organic matters serve principally to the nutriment of our respiratory organs, and the azotic matters are applied more particularly to the renovation of our organic tissues. As the respiratory materials may be replaced by many substances, such as alcohol, sugar, and the like, the richness in azotic matters should guide the baker in his choice of the flour he employs. The richness of the flour in gluten presents also another advantage, which is that the dough is rendered thereby more plastic. With a view to determine this quality with rapidity various apparatus have been devised, which we need not describe here, the most efficient of which are Boland's aleurometer and the appreciator of M. Robine.

By the addition of water to the flour, the dextrine and sweet material (the proportions of which are augmented by the reaction of some traces of diastase on the hydrated starch) are dissolved, as is also a portion of the albumen, caseine, and salts, and the insoluble principles starch, gluten, fibrine, are diluted with water. The flour kneaded with water yields a compact paste, from which bread of a heavy nature may be made, but by the addition of leaven the fermentation causes reactions between the elements and the glucose, which produce carbonic acid and alcohol. Carbonic acid, which is gaseous, augments the volume of the paste, which becomes inflated, and is lightened by the cavities which the gas retained by the gluten produces. The use of leaven is very ancient, since at certain periods the Hebrews used azymous (*i.e.*, unleavened) bread.

In the language of bakers the leaven is a portion of dough withdrawn first at the end of each operation, and in which the influence of water and air has effected the formation of the ferment. It may be replaced for the first operation, and its strength maintained for the subsequent operations, by yeast, which acts more quickly; but when employed in too large a proportion this latter substance is apt to communicate to the bread somewhat of the bitterness and peculiar odour of the beer, and especially of the hops.

The leaven is put into a place of a mild and uniform temperature, where it is left seven or eight hours, during which time it gradually increases in volume, and emits a faint alcoholic odour; thus the *chief leaven* is obtained. It is then mixed with a sufficient quantity of water and flour to double its volume, whilst preserving the mixture in the form of a firm paste; the result is the *first leaven*. After the space of six hours the leaven is renewed by an addition of water and flour, which again doubles its volume, and thus the *second leaven* is obtained. Finally, more flour and water are added, so as to again double the volume, and it is carefully manipulated similar to the preceding additions, which yields the *complete leaven*, the volume of which in winter is equal to about one-half the quantity of dough required for a batch, and in summer to one-third only.

The kneading process is the next in order, and it consists of several operations. The leaven is diluted with the requisite quantity of water for the preparation of all the dough, and a little salt is added, about 1 lb. per sack of flour containing 3 cwts., to improve the taste of the dough. It is then worked up so as to divide the whole into a semi-fluid paste, free from lumps, and when perfectly homogeneous a sufficient quantity of flour is added to form a paste of a suitable consistence. It is then worked together in a single mass in the kneading trough, where it is turned about from right to left, and then gradually worked back again from left to right; the workman takes up as much as he can hold and allows it to fall with all its weight, in order to admit of the free access of air thereto, which is favourable to fermentation. The dough is then divided into balls of a weight equal to $\frac{1}{15}$ or $\frac{1}{16}$ per cent. of bread to be obtained, which are sprinkled with a little maize flour and turned over and placed between the folds of a long cloth, or into a basket lined with a large cloth well floured. Fermentation is renewed under the influence of heat, and the balls gradually "rise." The agitating motion necessary in kneading becomes increasingly difficult in proportion as the elasticity of the gluten manifests itself, and as the mass becomes more homogeneous. When the flour is rich in elastic gluten, and all that concurs to render elasticity permanent is in united action, the operation of kneading is very arduous, so that it is usually one of the most robust workmen who is employed for this purpose.

The object of kneading is not merely to mix flour and water so as to form a paste, but also to incorporate the leaven with the paste, that so the former may be distributed equally throughout the entire mass, and communicate thereto its germ of fermentation. The process of fermentation has therefore to be carefully watched, so as to accelerate its progress or stop it at the requisite points. It is necessary that the baker should possess an acquaintance with the nature and properties of the bodies composing the flour, the temperature of the water and air, and the strength of the yeast, in order to properly regulate the process.

The division of the dough requires also to be performed with care and promptitude, for it is in this operation that the elasticity of the dough is developed, and the air being repelled raises the gluten in effecting its escape, and prepares it for expansion during the process of fermentation. The dough, when being kneaded, should be raised, worked about and drawn out; but never severed or macerated. It may be here observed that the continuous and general motion of the dough is attended with considerable difficulty, which has led to the failure of many mechanical kneading troughs. In kneading by hand, the fermentation is not interrupted for more than an instant, and then only partially, for directly the portion of the manipulated dough leaves the hands of the operator, the fermenting process, which had been momentarily suspended, is renewed; whilst in the mechanical operation the continual agitation of the dough prolongs the deadening action. It is for this reason that it is necessary to allow it to stand in order to become leavened afresh, before it assumes the form of bread. All the kneading operations should, therefore, be effected by intermittent motions. By taking these facts into consideration, considerable improvements have been effected in the arrangement of mechanical kneading troughs, until they have now arrived at such a state of perfection as to leave nothing more to be desired.

Among the most successful efforts to adapt mechanical appliances in the manufacture of bread, we may mention those of M. Deliry-Desbones, of Soissons (Aisne), whose kneading troughs were in operation at the Champ de Mars, during the period of the late Paris Exhibition. The trough is a cast-iron basin which turns on a vertical axis. The interior is provided with a kneader shaped like a lyre, which first works up the dough and then divides it during the entire period of the operation. Two other implements also are used, of a helical form, to draw out and inflate the dough in all directions, part by part, as is practised in kneading by hand. The dilution and drying are performed in less time, and in a more efficient manner than by the ordinary means, twelve or fifteen minutes being sufficient to work 2 cwts. or 3 cwts. of flour, according to the size of the basin. It also answers equally well for the making of leaven, and offers great facilities for cleaning, which is effected automatically during the operation. The baker in charge can regulate the paste without stopping the mechanism. The water and leaven are first introduced, the trough is then set to work, the "workers" employed to manipulate the dough are put in gear, and the leaven being diluted and flour added, the kneaders are also put in gear. After the lapse of twelve or fifteen minutes the dough is sufficiently kneaded, and by turning the hand-wheel fixed to the screw on the vertical shaft, the three kneaders are thrown out of gear. The implement which effects the cleaning of the trough is then removed, and its place supplied by a balance-hook, by which the dough may be weighed in the kneading trough itself. It is simply necessary to turn the basin on its axis as required, until the whole of the dough is weighed.

ON THE CHEMICAL HISTORY AND REACTIONS INVOLVED IN THE FORMATION AND IN THE SETTING AND HARDENING OF PORTLAND AND OTHER CEMENTS OF THE LIKE CLASS.

(*Continued from page* 197.)

THE burning of the cement is effected generally in kilns of a height of from 40 to 80 feet, and of a diameter of from 7 to 12 feet. The sufficiently strong fire-grate, which is placed about 3 or 4 feet above the ground, can be removed after the burning is finished and the kiln is to be drawn. The raw materials, which must be properly mixed according to the precedingly-assigned proportions, which again must be exactly calculated, are generally formed into bricks, which, as soon as they are air-dry, are placed in layers alternating with the fuel, in such a manner that the gases of the furnace may produce an equal temperature by easily finding everywhere a passage. Generally coke is employed as fuel, because a very clean material is required. A large content of ashes pollutes the cement, and the presence of sulphur produces a formation of gypsum. Coal and peat require a different construction of the kiln, as neither of these ought to come in contact with the cement by reason of their ashes. The ring-kilns, which have lately been put into use, and with success (Amöneburg on the Rhine), prevent the disadvantages of the commixture with ashes. These kilns, we believe, are on the principle of Hoffman's patent brick kiln. The right degree of heat for each material is to be found by experiment. A denser fuel requires a sharper draught; stone lime (*steinkalk*) and mud chalk (*schlämmkreide*) demand more heat than unindurated alluvial lime (*wiesenkalk*), and therefore also higher kilns. The degree of heat, however, is not between very narrow limits. The required temperature is a white heat. The carbonate of lime becomes caustic under a red heat, and acts upon the alumina at or under a strong red heat, so that when that is maintained for only one hour all the silicic acid of the clay is found soluble; the mass is light yellow or brown, gets hot in water, has only a small capacity for hardening, and falls in the air to powder. With a white heat the mass gets gray or nearly green (through a combination of oxide of iron, lime, or silicate). Under a greater heat a blue-gray colour sets in, and a deterioration of the cement takes place; it gets continually denser, more basaltic in appearance when in mass, and melts at last into an obsidian-like glass. The cement mass gives in the first stage a light, yellow-brown, loose powder; in the second one, which is the normal condition, a gray gritty powder, passing nearly into a green-gray colour; in the third one it is decidedly blue-gray; while in the last one the vitrified cement produces a light white-gray and very sharp gritty powder, as we know it of all glasses.

It is further of importance that the cement "stands" well; that is to say, that the bricks formed of it do not fall to pieces during the cooling. That takes place with the blue-gray or too much burnt cement, but also occasionally with normally burnt cement; the latter then appears as a very fine light-brown powder. Different experiments, undertaken for the examination of this phenomenon, have shown that a cement rich in alumina ($59{\cdot}2$ Ca O + $26{\cdot}3$ SiO_2) always thus falls to pieces; that as respects the burning the reason for this falling to pieces is that there has been produced at the same time, in consequence of too great a heat, a dead-burnt blue-gray powder, and that this falling to pieces may be prevented by a larger addition of lime, and still easier by a little alkali. The latter addition has the disadvantages that through it, at a low temperature, blue-gray masses are here and there produced, notwithstanding that through the addition of an alkali the change of volume takes place much more rapidly, that the masses exfoliate and split much more, and that they are easier acted upon by the air when exposed.

The finer the mixture is, the greater may be the addition of lime. But a great addition of lime is injurious to an already bad mixture; the cement alters its volume, swells, and splits. Michaelis took for 100 equivalents of SiO_2 (R_2O_3) as normal and for the average, 216 Ca O, and found, after extensive trials, that under 200 equivalents Ca O, the falling to pieces still occurred, but that above 240 equivalents Ca O, a swelling of the cement takes place: so that it seems advisable not to go below 220; that the limit of 240 may be nearer approached the better the mixture is; and that the cements which contain much lime contract much more slowly, but harden in a superior manner. In the arranging of these formulæ the small proportion of magnesia present has been neglected, but if that is large it will be necessary to take it into consideration. The small amount of alkali present in the raw materials has likewise been neglected, and the rather as that separates during the hardening of the cement. It cannot be stated too often that the most intimate mixture of the raw materials is of the greatest importance. Whosoever does not attend to that sufficiently, and yet seeks the faults he will find in his results in other circumstances, will often find himself quite helpless and bewildered, for he may mix together imperfectly, lime and clay in any proportions, and yet they will all prove of no use for the production of first-class cements. In fact, the sufficiently intimate admixture can only be effected in one way, namely, by elutriation and subsidence together of the respective powders from their impalpable suspension in water, as in the production of the mixtures of earths, &c., for the formation of porcelain.

WOOTTON'S PATENT DETECTOR ENVELOPES.

A PAPER envelope for a letter, as it is commonly made, is a most unsafe vehicle for the sure and secret transmission of correspondence. Gummed only as usual, it can be opened without subsequent detection by merely placing the gummed side for a few minutes in the steam from the spout of a common kettle, or by wetting that side thoroughly along the closure with pure cold water; and it can be closed again apparently just as before.

Without gum and sealed with wax, any moderately adroit person can soften and melt the seal over a common candle, gas-light, or spirit lamp, or by bringing near it the extremity of a red-hot poker, and if a wax seal be previously made, or a *cliché* in fusible metal, from the seal, the envelope can be sealed again with its original impression, so that to a casual observer its having been opened remains unknown.

The combination of gum and wax presents rather better chance of protection, but in *habile* hands it proves to be none. If, in fact, the gummed side of the envelope be thoroughly soaked with cold water poured over it as it lies upon a level surface, the moisture finds its way in under the seal of wax at both ends of the junction of the line of gumming with the seal. If then the envelope be partially dried by a piece of clean blotting paper, and the hot poker be held over the wax seal, the whole becomes loose and the envelope can be opened, and with the previous preparation of the false seal, can be re-sealed just as before. This is what is actually done in the "black parlour" of foreign post-offices, and what was done some years ago under the Administration of Sir James Graham, in our own post-offices, to detect Irish or foreign conspiracy, to the intense disgust of all English feeling men at the time. There can thus be no doubt of the great value of any contrivance by which, retaining the rapid facilities of the common gummed envelope, such vehicles for correspondence could be made secure against curiosity, theft, or traitorous prying.

Having recently received circulars announcing that "Wootton's patent detector envelopes" fulfilled these desirable conditions, that "they cannot be opened by damping, steaming, or other means without being defaced," we sent to the manufacturers in London and secured a sample of 100 envelopes. Our expectation that the wished for end had been in some unknown way (for we have not been able to find the specification) at length discovered, was destined to a rapid disappointment. We found, in fact, that no more was necessary than simply to moisten the gummed side freely with cold water and the envelope opened, just like the most vulgar one "to be fastened with a lick," which we might find anywhere. Were these envelopes purchased anywhere but from the patentee and manufacturer, we might assume a substitution; but as matters stand, we fear there is some mistake, not to employ any harder phrase. In any case the discovery is yet to be made.

Any one who can find a cement in lieu of gum or like material, that when applied and dry upon the envelope can be moistened and made adhesive by the saliva or by water, and yet which cannot be so dissolved a second time; or any one who can produce a convenient adhesive liquid with the means for rapidly, easily, and with cleanness applying it to the envelope at the moment of closing it, and yet of such a nature that neither steam, nor dry heat, nor water, nor such other solvents, as spirits of wine, ether, chloroform, benzine, &c., which do not destroy the paper nor leave any mark behind, shall be all incapable of again softening this cement—will have made a discovery which we predict will lead to a fortune if rightly handled.

At the time of Sir James Graham's exploits above alluded to, the writer of this article published a communication in the *Mechanic's Magazine*, in which he stated, that the thick glutinous juice which is found in considerable quantities in the interior folds of the leaves of the New Zealand flax (*Phormium tenax*), and which is, in fact, a sort of hemp, in natural solution, possessed the properties here to be desired. While liquid it can be used as common gum; but once dry, no ordinary solvent has any action upon it. This natural product might be collected, and probably without prohibitory expense and in sufficient abundance, as the *Phormium* is a New Zealand weed, covering whole square miles. It is still open to experiment for the colonists there to add this to their produce, and it is for some of our Waterlows or Spottiswoods to initiate it, by getting to England such a first supply of the juice as would enable our chemists to examine its precise nature, and to assign the conditions for, and limitations to, its use for envelopes.

It is said that silk dissolved in chloride of zinc affords another sort of liquid cement presenting some, at least, of the characters here needed; but it has others which are objectionable, as tending to destroy in time the paper. Again, it is stated that a solution of pure woody fibre in ammonio-chloride of copper embraces the requisite properties. Dr. Scoffern has, we believe, experimented a good deal upon this and other uses for this very singular compound, but we are not aware how far it has been found suited to closing envelopes. We should not anticipate well of it in some respects, and those the same as render the silk solution objectionable.—ED.

CERAMIC PRODUCTS.

THE following is the substance of an article on the ceramic products in the Exhibition, by Messrs. A. & L. Jaunez, which we translate from the "Etudes sur l'Exposition" of M. Lacroix:—

Ceramic products may be divided into seven classes, viz.:—

1st. Clay, or mixtures of clay, shaped and submitted to a single baking, such as bricks, tiles, drainage tiles, artificial pavements, and baked clay articles in general.

2nd. Clay, or mixtures of clay, combined with other materials, pounded or brayed, and shaped and baked once. This class includes refractory bricks, ceramic grit, paving flags, and minor figures in biscuit, parian, and other similar compositions.

3rd. Clay, or mixtures of clay, shaped and baked a single time, but covered, either previous to or during the process of baking, with a vitrifiable coating or glaze, which is transparent after its fusion.

4th. Clay, or mixtures of clay, fashioned and baked once, then covered with an enamel which is usually white and opaque, but sometimes coloured and more or less transparent, and subsequently submitted to a second baking process in order to fuse the enamel on to the piece. Crockery-ware *proper* composes this class. The term, mixtures of clay, does not exclude marly clay, which is frequently employed in the four classes of products we have just enumerated.

5th. Clay, or mixtures of clay, combined with various materials and forming a composition which, after having been shaped and once baked, is covered with a layer of transparent glass, and then passed a second time into the kiln in order to melt the glass. The products of this class are not translucid, and are known as earthenware.

6th. Same method of manufacture and same process as those of the preceding class, with this difference, that the products are translucid after the first baking. This class comprises the different varieties of soft china, including the English bone china, the most important of all.

7th. White clay, known as kaolin or porcelain clay, mixed with other substances and forming a consistence which, after having been formed and submitted to a preliminary baking at a low temperature, has a felspathic coating applied thereto, and is subsequently rebaked at a very elevated temperature, in order to fuse the coating and give the product the requisite translucence. This class is composed of true porcelain, the hard porcelain of Germany, France, and China. It is submitted to a higher temperature than any other of the ceramic products.

The methods of ornamenting and decorating ceramic products by means of colours, metals, lustres, enamels, &c., may also be classified as follows:—

1st. Decorations on the unbaked article by means of incrustations, reliefs, colours, &c.

2nd. Decorations on the article after it has been once baked but unglazed, comprising painting and the impression on biscuit, and more rarely, the application of colours by immersion in mixtures of metal.

3rd. Decorations in vitrifiable colours, applied on enamel or on transparent felspathic glazing, consisting of painting, engraving, lithographic, and even photographic, impressions. Sometimes with crockery-ware the painting is effected on the enamel before its fusion.

4th. Decorations by means of enamels and coloured glass, employed separately or superposed and in juxtaposition. In this the decoration serves at the same time as a glazing and a colour ornament.

Very beautiful and valuable products have been obtained by mixing ceramic pastes of different colours after the manner of stucco, and after submitting them to the process of baking, to cut and polish them like agates and crystals.

We will merely add that species of baked clay, known in Germany under the name of *sidérolithes,* which have a plumbiferous glazing, and are coloured by means of oil. It is manufactured in a few works in Saxony and Bohemia, but its use is very limited.

Ceramic Products of the 1*st Class.*

The essential products of this class, viz., bricks and tiles, were not very numerous at the Exhibition, and being so widely dispersed, not only in the gallery of the building, but also in the most distant corners of the park, it was almost impossible to examine them all.

There are no very great difficulties to surmount in the manufacture of these articles. The choice of a good clay, the preparation of the paste, and, in articles of large dimensions, a carefully managed and slow drying operation after the forming, and finally the baking, at a given low temperature, in suitable ovens—these are the principal things to be attended to in the manufacture of baked clays.

Although these products may not be very attractive to amateurs, independent of the archæological interest which is always attached to products of antiquity, they nevertheless claim a high position by their utility in buildings: wherever stone fails brick is substituted for it, and whole towns, as London for instance, are built of bricks, and frequently roofed with tiles. The strength and durability of such structures depends entirely on the quality of the materials employed, not excluding, of course, the quality of the mortar used therein. The bricks and tiles may be of very inferior quality, and when exposed to the air they very rapidly deteriorate, more especially under the influence of frosts, whilst bricks of good quality will resist for an almost indefinite period the inclemency of the seasons. The degree of baking and the nature of the clay employed are the two essential conditions on which the quality of the products depends. Builders who employ bricks in countries where their use is limited, and where consequently there are but few data by which to determine their qualities, cannot be too careful to satisfy themselves as to the quality of these products before applying them at the exterior of building.

Bricks are also frequently employed for paving purposes, and they form, without doubt, the most economical pavement, and are of great utility when the brick is good and sufficiently baked, as is proved by their results in many English towns where the pavements are constructed of bricks. We observed at the Exhibition, among the English products, some fluted and paving bricks of excellent quality, exhibited by the Bishops-Waltham Company. On the other hand, brick pavements, when unequally and insufficiently baked brick are used, are detestable. They quickly wear out, and have the additional defect, that after a short time the softer bricks, by being destroyed more rapidly than the others, form hollows and cavities, the consequence of which is an unequal surface extremely inconvenient and disagreeable. Ordinary bricks, when insufficiently baked, may generally be detected by their reddish yellow tint, and by their admitting of being easily cut with a knife; whilst those which are well baked have a reddish brown colour, darker according to the intensity of the fire to which they have been subjected. A good paving brick, too, so far from admitting of being cut with a knife, will strike fire on being struck with a piece of steel. However, there are varieties of clays which, though but moderately baked, are capable of producing good bricks, that will withstand atmospheric action. Experience is here the surest guide. At any rate, bricks the most baked should be invariably preferred for the external walls, the softer bricks being used only for the interior of buildings.

Our remarks on the subject of bricks are still more applicable to tiles, which also deteriorate much less quickly according as they are harder and less permeable. Vegetation should not take place thereon, as is often the case on tiles badly baked. It is with a view to obviate this defect in ordinary tiles that enamelled tiles, and tiles coated with a plumbiferous glazing, have been made, which in addition to their utility, contribute also to the ornamentation of the roof. We should not omit to mention that the more tiles are baked their cost is increased, and they are more liable to lose their shape, for which reason manufacturers are careful to submit them to the action of the fire for only such a period as they may deem absolutely necessary; this rule is of the utmost importance in the manufacture of mechanical tiles, as it is indispensable that these tiles should be straight and of exact and uniform dimensions.

Since tiles have been manufactured by the press their form has been varied to an infinite extent, either with a view to improve them or to make such diversifications as it would be difficult to copy. The advantage that these tiles possess over the old hollow tiles is that their weight is but one-half to cover the same surface. They weigh on an average 3 kilogrammes, and twelve or thirteen of them are required to cover a square metre. When they are well made and properly laid the snow cannot penetrate through them, and they require no greater inclination than the hollow tiles. As regards the plain tile and pan tile, it is well known that they require considerable inclination, and that the latter is obliged to be laid with straw or mortar to render it impermeable to snow. The pan tile weighs 2 kilogrammes; twenty are required to cover a square metre.

Hollow bricks have during the last few years acquired considerable importance in buildings, and their form and that of their cavities have undergone considerable modifications. This kind of brick, from its lightness, is particularly suitable for partitions; it is almost exclusively employed for small vaulting between the girders, but *voussoirs* have also been made in pottery in à single piece to form such vaulting. The bricks and tiles are usually manufactured in the same establishment, together with a multitude of other articles, the number of which daily increases with the progress of ceramic industry, and tends to multiply the resources and production of this branch of manufactures.

Among the ceramic products of the first class which have most attracted our attention, we may mention those of Messrs. Emile Muller & Co., Quai d'Ivry (Seine); of La Société Ch. Avril & Co., Moutchanin-les-Mines; of the Bèze Tileworks (Côte-d'Or); of M. Damiens, Ville-navotte (Yonne); the very fine products of Messrs. Gilardon Brothers, Altkirch (Haut-Rhin). Among the exhibits of Billancourt we may name the fine conduit tiles manufactured by M. Constant Zeller (Haut-Rhin), and the products of M. Reynaud-Pillard, near Troyes.

The busts, statuettes, &c., of baked clay, although obtained by analogous processes to that described, belong rather to the domain of sculpture and pure art, and it is therefore unnecessary that we should enter into any further description of them.

(*To be continued.*)

IMPROVED BOILER FOR HOT-WATER APPARATUS.

(*Illustrated by Plate* 9.)

THOSE who have devoted the greatest attention to the subject of warming and ventilation, agree that the system of warming by the circulation of hot water through pipes at a low pressure is the best and most economical mode of applying fuel for that purpose, provided the boiler employed be constructed on proper principles. Many ingenious attempts have been from time to time made to render the boilers of hot-water apparatus *self-regulating;* that is to say, that they shall, by the expansion and contraction of liquids or metals directly influenced by the temperature of the water in such boilers, cause a damper or regulator to open or close more or less, and thereby regulate or control the supply of air to the furnace, as may be required. These arrangements, however, are in fact refinements of mechanical detail too delicate to stand the absolute test of actual wear and tear, and have consequently been abandoned. As the circulation of hot water through pipes means in reality the distribution of the heat generated by the combustion of fuel under or within a boiler, it is obviously of primary importance that the source of such heat, namely, the boiler, be so constructed as to produce the greatest effect with the least consumption of fuel. The Plate engraving illustrates an improved construction of boiler, which has been recently introduced to public notice by the inventor, Mr. George Bower, of St. Neot's. Fig. 1 represents a side elevation of a self-contained boiler constructed on Mr. Bower's system, fig. 2 is a plan thereof, fig. 3 is a sectional elevation, and fig. 4 a horizontal section corresponding to fig. 3.

The wood engravings, figs. 1 and 2, represent respectively a sectional elevation and horizontal section of the same kind of boiler set in brickwork, and adapted for large establishments.

The peculiarity of this boiler is that it is built up of a number of cast-iron tubes, *a*, having hollow bosses, *b*, cast on each end, and placed either vertically or horizontally. The bosses are fitted to each other by properly-faced surfaces, so as to form water-tight joints; the circulation of the water being effected by so arranging the ends of the tubes that they shall communicate one with the other without requiring circulation boxes or receptacles for the tubes. By this system facility is

Fig. 1.

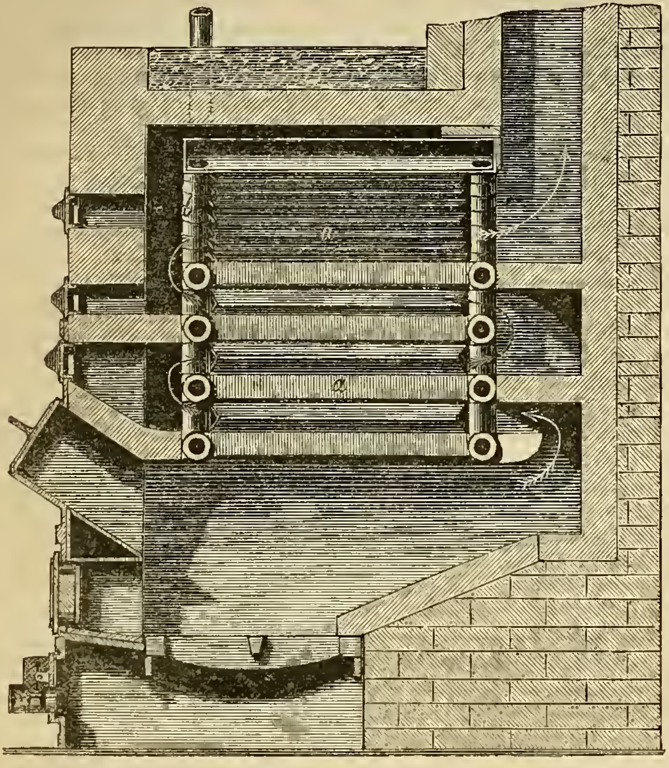
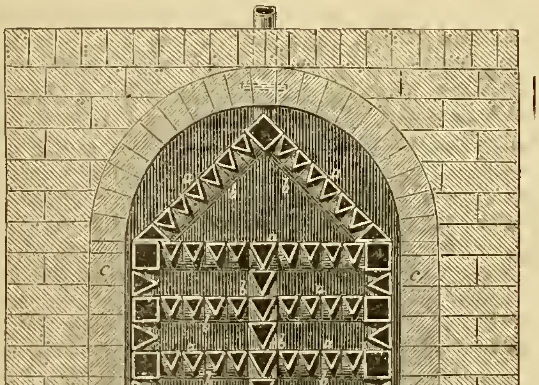


Fig. 2.



obviously afforded for erecting a boiler of any magnitude, it being simply necessary to bolt any desired number of the tubes together. The inventor prefers the form of tube shown in the engravings, namely, a triangular section; but, of course, any section will answer that will afford a large heating surface. The self-contained boiler is inclosed in a sheet-iron or cast-metal casing, *c*. In order to insure perfect joints one surface of each boss is provided with a projecting rim, and the corresponding surface of the adjoining boss has a recess or groove formed therein, into which the rim fits and is made tight by the mere application of a thin coating of suitable cement, which may be done with a brush. The several tubes are held together by means of long wrought-iron bolts passing through each row or series of hollow bosses, and tightened up by nuts on the outside of the tubes. Should a defect in any one of the series of tubes be discovered, it can be readily removed and replaced by a new one, as all the tubes are faced to one gauge. These boilers may also be enlarged at any time by the mere addition of more tubes, without necessitating the removal of the old boiler. With regard to the regulation of the rate of combustion of the fuel in self-contained boilers, a simple plan, based on the principle of Dr. Arnott's well-known regulating valve, is found to answer all practical purposes, whilst it possesses the advantage of being much less costly than valves, which are operated only by the heat of the water acting on mercury.

For small establishments a self-contained boiler, such as that illustrated by the Plate engravings, will be found most convenient by reason of its easy management; but where economy in fuel becomes an object, as in the case of large establishments, the inventor prefers to set the boiler in brickwork, as illustrated by the wood engravings.

ERRATUM.

At page 194, Part XLIII. (for October, 1868), article on "Boiler Plate Balloons," for the formula, printed

$$R = 0{\cdot}0375\,\frac{D^2}{1{\cdot}273}\sqrt{\ }^2$$

read

$$R = 0{\cdot}0375\,\frac{D}{1{\cdot}273}V^2$$

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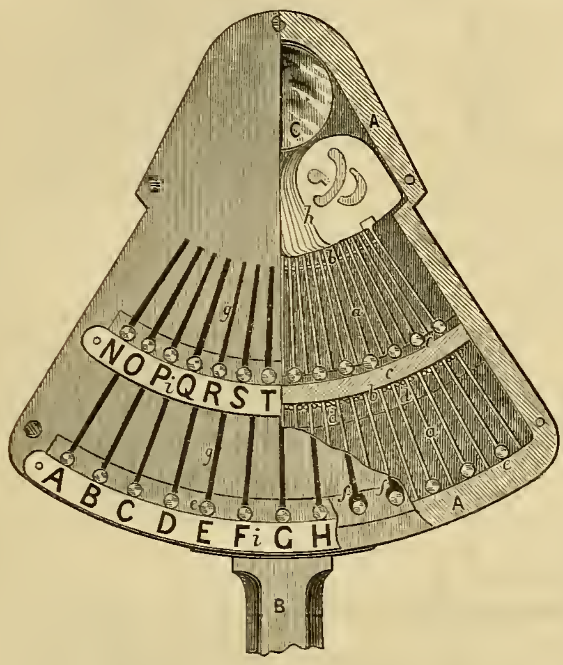
RECENT PATENTS.

TEACHING THE DEAF AND DUMB.

Bertram Mitford, *of Cheltenham.—Patent dated* 30*th March*, 1868.

This invention relates to a peculiar form of apparatus for facilitating intercourse with deaf and dumb, or deaf or dumb persons, and consists of a hand telegraph composed of a hollow case of any convenient form and size, made of wood or other suitable material, and provided with a handle whereby it may be easily held in the hand of the user. On that side of the said case which is intended to face the user, there are contained the letters of the alphabet, numerals, or other signs useful in personal intercourse; and upon the opposite side, or that which faces the person communicated with, there is provided an aperture which may be protected by glass. In the interior of the hollow case are disposed a number of sliding wires, worked by buttons which traverse along slots disposed each immediately above a different letter or sign. The upper end of each of these sliding spindles carries the corresponding letter or sign to that marked on the case opposite to the particular button; and when any slide or button is pushed along the slot, the corresponding letter or sign will be presented at the glazed aperture on the opposite side of the case. By successively raising or lowering and moving the slides, it is obvious that words can be easily spelt, and communication be thus established with the deaf and dumb, or deaf or dumb, without necessitating a knowledge of the signs known as "the deaf and dumb, or finger alphabet."

The engraving represents a front elevation of the improved apparatus, which is named "the Hand Telegraph for the deaf or dumb," with one-half of the cover removed to show the internal arrangement. A is a flat or shallow box or case made of wood, light metal, or other suitable material, and by preference of a quadrant shape, as shown, for the facility of disposing of, or arranging the movable parts carrying the letters or signs to be exhibited, as well as the quadrants containing the corresponding letters and signs indicated outside the case. In the interior of the case, A, are disposed in a radial or converging direction a number of sliding spindles or wire rods, *a*, *a*, guided laterally and maintained at equal distances apart by passing between guides, *b*, *b*, secured to the interior of the back of the box or case. These several sliding wires or rods are held down in their places by the cross-bar, *c*, the rubbing surfaces of the said bar and of the back of the box being faced with leather, if desired, as shown at *d*, *d*; *e*, *e* are buttons fast on the sliding rods, *a*, and projecting through the front of the box at right angles to the said sliding wire or rods; these buttons pass through circular openings, *f*, with which openings long and narrow slots, *g*, made in the front of the box or case communicate. The several buttons, *e*, traverse these slots, a flattened portion of the buttons entering the said slots. The instrument illustrated contains the letters of the alphabet, and the sign "&;" these being perforated or cut after the manner of stencil plates in thin plates of metal, *h h*, each attached to its respective rod, *a*, the button of that particular rod corresponding in position with the same letter or sign on one or other of the two indicating quadrant plates, *i*, *i*. In order to economize space, the plates, *h*, and rods, *a*, are disposed in two tiers or series, one behind the other, separated by a partition of thin sheet metal, *k*; the one series corresponds to the letters in the upper or smaller quadrant, and the other to the letters or signs in the lower or larger quadrant. B is a handle secured to the wider part of the apparatus, by which it is held by the user, and C is a small glazed aperture, made in the back of the box or case, through which any letter or sign, moved up by sliding one or other of the buttons along its slot, may be presented to the view of the person with whom communication is being held. Care should be taken in spelling out the words by the aid of this instrument, that one letter be moved up to the aperture, C, and withdrawn again from sight before another is acted upon.



IMPROVEMENTS IN STEAM-ENGINES.

E. N. Dickerson, *New York.—Patent dated* 31*st January*, 1868.

This invention relates to a new and useful improvement in the valve-gear of steam-engines, which, when in use, require to be reversed; the object of which improvement is to remedy the defects, and retain and improve the advantages of the "link-motion," as now commonly used.

By these improvements the steam valve is not opened until the piston reaches the end of the stroke, or a little later, and is then opened very gradually for a short time. While the steam valve remains open, it supplies the cylinder with steam, without any material reduction of pressure in consequence of a contracted opening. When the cut-off slide closes the port, its motion is so rapid as to be practically instantaneous. The exhaust valve does not release the steam until its force is effectually expended, and then it opens so rapidly as to release the steam instantly. And the opposite exhaust valve does not close until the piston has reached the extreme end of the stroke, so that no "cushion" is formed. Thus all the disadvantages of the ordinary "link-motion" are remedied, and its advantages retained by means of a link which reverses the engine, but which is so constructed as to reduce the wear upon itself and its connections to an amount practically no greater than is incurred in the valve-gear of an ordinary stationary engine incapable of being reversed.

When the piston is at the end of the stroke, and the crank on the centre, it is apparent that no power can result from the application of steam pressure upon the piston; but the friction upon the journals and crank-pins of an ordinary locomotive during the first five degrees of the revolution of the engine from the centre absorbs more power than is generated by the motion of the piston during that time. Also, the sudden admission of steam into the cylinder produces a shock upon the crank-pins and journals like the blow of a hammer, making it necessary to reduce the slack of the connections by driving the keys hard; in consequence of which great friction, heated journals, and rapid destruction of the brasses are produced. With the link-motion, when working at or near full stroke, this sudden admission is not neutralized by a cushion. Therefore the engine must be keyed up very close for that position; and when the cut-off is short, and the cushion does prevent the shock of sudden opening, the keys are still tight, and the friction is augmented by the resistance of one piston against the other near the centres. The remedy of these evils is here effected by admitting the steam through a graduated aperture and "wire-drawing" it during the time occupied by the crank in moving through the first few degrees of the stroke, when full pressure on the piston would be injurious. This gradual admission of steam cannot be used advantageously in combination with the ordinary "link-motion," because when the link is cutting off short, which is its usual operation, the gradually accumulated "cushion" imposes a pressure upon the piston before the steam-valve opens, and thereby prevents a shock, and renders a graduated opening for the admission of steam useless for that purpose; while, at the same time, the slow closing of the graduated valve "wire-draws" the steam at a time when its pressure is needed in the cylinder, and thereby causes an absolute loss of power. But in this combination, where the cut-off is effected by an independent slide, a graduated opening may be used without loss; and there being no tendency to a blow or shock, no "cushion" is needed to anticipate and prevent it. Thus the disadvantages of the premature admission of steam and of the "cushion" may be remedied.

In the ordinary "link-motion," when used as a cut-off, the valve opens the port to a very limited extent, and very rapidly, but closes it very slowly; in consequence of which the piston travels five times as far while the valve is closing as it travelled while it was opening. The effect of this relation between the motions of the piston and the valve, is to "wire-draw" the steam and diminish its power. In the improved valve-gear, the main valve continues to open during the first 75°, more or less, of the revolution of the crank, as in the old-fashioned lap-valve arrangement, so that steam is always supplied in proportion to the demand of the cylinder, if not otherwise cut off or suppressed; but the improved cut-off valve is so arranged as to close with almost instantaneous velocity, which is not reduced or affected by its adjustment to different points of the stroke. By this means, the disadvantage of "wire-drawing" is remedied.

In the ordinary "link-motion," the point of exhaust varies with the point of cut-off, thereby releasing the steam earlier, as its quantity diminishes; whereas, if a variation in the time of exhaust were desirable, the greater quantity should be released earlier. In this valve-gear the point of exhaust is fixed in the construction of the machine, and may be set to the best advantage. In all cases, the ordinary "link-motion," when used as a cut-off, exhausts too early for economy; but by separating the cut-off valve from the exhaust valve-motion this evil is remedied.

In the ordinary "link-motion" the "cushion" is unavoidable. In the improved valve-gear, the blow or shock being prevented by the gradual opening, as before stated, the exhaust cavity of the main valve is elongated, so that both exhaust valves will be open at the same time near the end of the stroke, and the bar of the valve which covers the port is made only as wide as the port itself (line and line with it), so that the exhaust valve does not close until the steam valve opens, which is at or after the end of the stroke. Thus there can be no accumulation of steam or "cushion" in the cylinder at the end of the stroke; nor can water be caught in the cylinder, nor when working through the engine will it produce any jar or concussion.

In fig. 1 of the engravings a part of the engine-frame of an eight-wheel locomotive is shown, in dotted lines, with the cylinder attached, and fig. 2 is a plan and partial section of the same. The engine is represented on the after centre. On the shaft, or crank axle, is fitted the main eccentric with its rod, B. C is the cut-off eccentric, and G its rod. E is the link, which is connected, as usual, with the eccentric rod, B, at one end, but the other end is free. D is a radius bar, which is suspended by a strap on the main shaft, around which it vibrates in reversing the engine. The link, E, is suspended by the pin, T, to the end of the radius bar farthest from the shaft, in the same manner as the ordinary link is suspended to the reversing hand-gear. R is a hanger, the upper end of which is suspended upon the frame by a pin, upon which it swings. To the lower end of this hanger the ordinary link-block is suspended by a pin, which passes through it. F is a connecting rod, which connects the hanger and block-pin with the main rocker-arm, H, to work the main valve, L, in the usual manner. From the centre of the main shaft to the centre of the link-pin, T, through the radius bar, the distance is 30 inches, and from the centre of the eccentric to the centre of the pin, U, is $27\frac{4}{100}$ inches. From the centre of the pin, U, to the centre line of the link is 3½ inches. The hanger is 8 inches long from centre to centre, and the link is cut in a circle, the radius of which is 28½ inches to the centre line. The throw of the eccentric is 5½ inches, and the travel of the main valve 4½ inches. The tumbling-shaft, K, is connected with the centre of the link in the usual position, but around the hub of the radius bar, and by its vibration it elevates or depresses the link to the required positions in the usual manner.

Fig. 1.

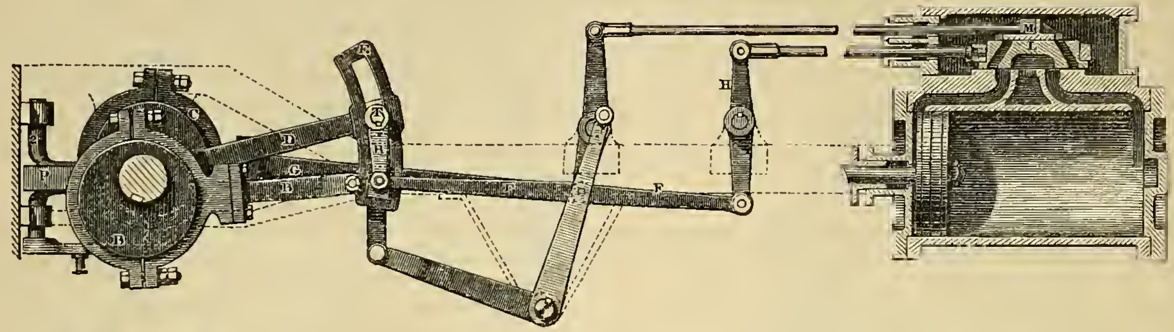


Fig. 5.

Fig. 4.

Fig. 3.

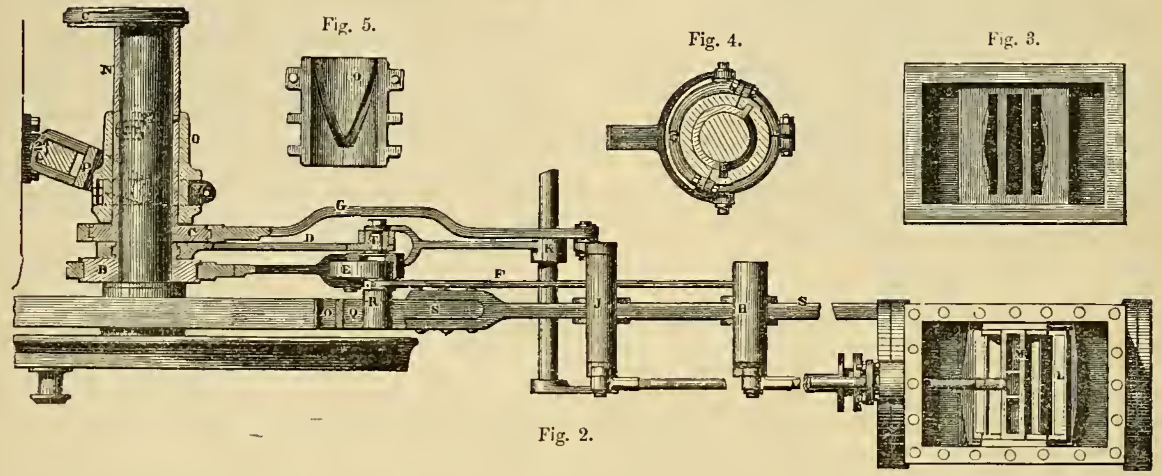


Fig. 2.

Fig. 3 represents a plan of the ports and valve seat. The steam-ports, instead of being rectangular, have their outside edges formed in the shape of an obtuse V, the point of the V projecting half an inch outside of the usual edge, and the widest part of the V being 7 inches across. The triangular opening thus formed ought to be one-ninth of the travel of the valve in length, and one-half of the width of the port; but this V shape may be made in the inside edges of the passages through the main valve, and the ports in the seat left rectangular. The proportion here given is suitable for engines making 100 revolutions a minute; but for slow-moving engines this V-shaped port may be more obtuse without producing a shock. For fast engines the ports should be cut in the shape indicated by the dotted lines.

The valve-gear is represented in the forward position, in which the axis of the centre-pin of the link is in the same line and centre with the axis of the centre-pin of the hanger, R; and as the radius bar, D, holds the centre-pin of the link firmly in that position, there can be no slip of the block in the link as it vibrates: hence, all wearing of the link and block is avoided, except that which results from the slip of the block in backing, when the link is lowered and the block works in its upper segment. When the link-centre is lowered so that it coincides with the centre of the block, the block is firmly held in the link, exactly 30 inches from the centre of the shaft; and although the engine may be running no motion is imparted to the main valve, and all the wear of valves, when the engine is shut off, is prevented; whereas, in the ordinary "link-motion," the valves are never at rest when the engine is moving. Another advantage results in this valve-gear from holding the valves still on the centre, which is, that both exhaust ports are kept open at the same time; and in running down hill the piston is not resisted by atmospheric pressure as it is by the ordinary "link-motion," and the engine will run without steam in many cases where steam would otherwise be required to keep the train in motion. This peculiarity will be found of very great advantage on railroads having heavy grades; because, in running down a grade of 1 to 130, with the ordinary "link-motion," the engine requires steam enough in the cylinder to balance the atmospheric pressure which resists the piston; and thus is wasted a quantity of steam, half as much as would be needed to drive the engine 30 miles an hour on a level. The improved link motion is not capable of producing a cut-off by itself, and is only valuable in combination with an independent cut-off; but it may be used advantageously with any of the forms of independent cut-off besides that herein described.

The improved apparatus for effecting an independent adjustable cut-off differs from all others in the fact that its adjustment is effected by varying the angular position of the cut-off eccentrics on the main shaft; in consequence of which any desired range of adjustment can be obtained, and the cut-off valve will always be closed at its highest velocity nearly. It may be used, moreover, with any reversing apparatus.

In fig. 1 one cut-off is shown in action, adjusted to cut-off near the commencement of the stroke. The cut-off slide, M, is just about to close the port through the main valve, L, which is just opening the point of the V-shaped port for the admission of steam at the commencement of a stroke. Fig. 4 is a transverse section through the main shaft, sleeves, and adjusting clutch of the cut-off apparatus. The eccentrics, C, are fixed upon a tubular shaft or sleeve, N, which in this case is cast in two halves with the eccentrics and bolted together. The eccentrics are at right angles with each other in the same direction as the crank-pins. This sleeve, N, surrounds the shaft, but is a loose fit, so that it may be turned upon it. In the middle of the sleeve there is a slot cut, about 2 inches wide, and running around the same in a plane at right angles to its axis for 130°. The object of this slot is to allow a pin to be screwed into the shaft, and to permit the eccentrics, notwithstanding the pin, to be moved around the shaft for 120°. When the eccentrics are at right angles to the cranks, and ahead of them as the engine moves forward, the pin should be screwed into the shaft at the back end of the slot. O is the adjusting sleeve or boss, which fits outside the sleeve, N, and is made in two semi-cylindrical halves bolted together. On the inside of this sleeve, O, two spiral grooves are cut, as seen at fig. 5, which are intended to receive the end of the pin, which projects beyond the sleeve, N, about 1½ inch, and also the block, X, which is fixed upon the inside sleeve at the end of the slot opposite to the pin as set. When the sleeve, O, is moved from end to end upon the shaft, the pin and the block, X, traverse the spiral grooves from end to end, and are brought nearer together or removed farther from each other in the direction of rotation. But as the pin is fixed in reference to the crank of the engine, it is apparent that the cut-off eccentrics must change their angular position to the cranks, as the pipe to which they are fixed is forced around the shaft by the spiral grooves acting upon the block, X; and so an adjustment of the cut-off will be effected through as many degrees of the revolution of the engine as the spiral grooves diverge from each other. The travel of the cut-off slide, M, is 8 inches, being an increase upon the throw of the eccentric produced by a difference in the lengths of the rocker arms. The point at which the cut-off will be effected varies about 1½ inch from the centre of the travel of the cut-off slide, so that the centre line of the eccentric must be very nearly at right angles to its rod when the cut-off is effected, and, therefore, must throw the valve, with nearly its highest velocity, at any possible point of cut-off; and by adjusting the lengths of the cut-off slide and connecting rods, the very highest velocity will be secured at the point of usual work with very little diminution of speed for all other points of cut-off. The longer the travel of the cut-off slide, the more perfect will be the cut-off; but 8 inches are enough for all practical purposes.

For the purpose of placing the adjustment of the cut-off within the control of the engine driver, a strap, Y, is passed in a groove around the sleeve, O, similar to an eccentric strap, but with one hinge joint for the sake of convenience instead of two bolted joints. At opposite points in this strap two pins, Z, are fixed, which pass through holes in the two ends of a reversing clutch, P, which clutch is forced from one side to the other along the sleeve, N, by a vertical shaft, 2, which has a projecting block on one side of its axis that fits easily into a mortice in the arm of the clutch, P. The shaft, 2, is vibrated from the footboard of the locomotive by means of a lever and bell-cranks and rods connecting with it in a manner well known to engineers for analogous purposes—the shifting-clutch being an apparatus well known, and used on some locomotives for altering the angular position and throw of the main eccentrics. Other means for varying the angular position of the cut-off eccentrics, when in motion, may be used for the purpose of effecting the improved method of cut-off; but this device is recommended in preference to any other for similar purposes, because it completely protects the spiral apparatus from exposure.

The link, instead of being curved, may be composed of two chords of arcs meeting at the centre; and a rectangular block will work in it, enough clearance being made at the angle of intersection to permit it to pass the centre. And inasmuch as the link only uses a small portion of its length at each end and in the centre to give position to the valves, its other parts may be of irregular form, but a true curve is the best.

In running a locomotive constructed upon this plan the throttle-valve and pipe, which should have an area of one-tenth of the area of the cylinder all the way to the chests, should be thrown wide open after the engine is fairly started, and the speed of the machine should be regulated entirely by the lever which controls the position of the cut-off; whereby the steam will always be admitted to the cylinder at a pressure very near to that in the boiler, and the greatest range of expansion which the load will permit will at all times be obtained, and, consequently, the greatest economy of steam will result. By the use of this improvement the entire theoretical power which steam is capable of producing in a non-condensing engine of a given size, and performing a given work, will be produced in a locomotive engine, with no deductions except those due to the "clearance," the radiation of heat, and the leakage from imperfect construction. And of the power thus produced much less will be absorbed by friction when the engine is worked by the improved valve-gear, because there is no resistance by one piston against the other at each centre, as there is with the "link-motion," and because, there being no shock on the centres, the keys may all be slack, and so there will be no binding of the brasses. The loss by leakage, also, will be much diminished, because the travel of the valve is constant; whereas with the "link-motion" the valve is generally moving with a small travel upon the seat, which it wears down in the middle, and when the travel is increased, as it must be frequently, the valve runs against an elevation left by the reduction of the middle surface of the seat, and the effect is to wear the valve into a curved surface, touching the seat on its centre, and rocking either way. The steam then leaks under the ends of the valve and is wasted, as may be seen in any "link-motion" engine which has been running a month, by setting the slides in the centre and opening the throttle valve and cylinder cocks.

BREECH-LOADING FIRE-ARMS AND CARTRIDGES.

La Société Industrielle Suisse, *of Newhausen, Switzerland.—Patent dated 23rd November*, 1867.

This invention relates both to repeating and non-repeating breech-loading fire-arms, and to the construction of cartridges for breech-loaders.

The improved repeating fire-arm is represented in side elevation and transverse section at figs. 1 and 2 of the wood-cuts, and in longitudinal and transverse section at figs. 3 and 4. It consists of a piece of forged iron, A, which serves to carry the whole of the mechanism, and receives at one extremity the barrel, Y, of the gun, and at the other the wooden stock, Z. In this piece, A, works a slide, which is provided with a groove, *a*, in which works the cartridge-case extractor, C. This extractor terminates in a hook, *b*, which lays hold of the flange of the cartridge, and is retained in the groove, *a*, by a pin, which passes through an oblong opening made in the projection, *d*, of the extractor. Two projections, *c*, which come in contact alternately with the key, F, guide its to and fro motion, and maintain the slide, B, in the piece, A. The striker consists of a rod, D, placed in the centre of the slide, B; it is kept in its place by the nut, G, which also serves to secure the piece, I, and the lever, J. In some cases the rod, D, in lieu of striking the cartridge in the centre, bears against a forked piece E, of which the prongs, *e*, *e*, strike the case of the cartridge containing the fulminate. The slide, B, is provided on its under side with a groove, *f*, which serves as a guide to the lever, L, of the elevator, K; it is, moreover, cut away or hollowed slightly on either side in order to diminish friction. It carries also a spring, H, which is so disposed that it is only when the slide, B, is completely drawn back into the piece, A, that it

Fig. 1.

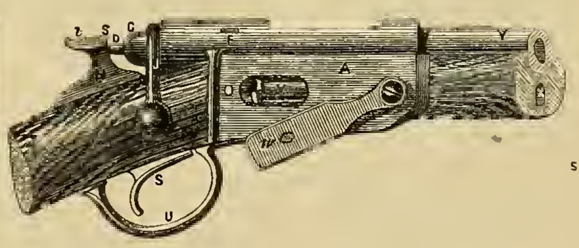
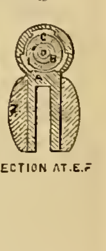


Fig. 2.



SECTION AT E.F

permits the piece, I, to move under the action of the lever, J, in order to lock the slide, B, in the piece, A. This piece, I, is provided on its circumference with three projections, *b*, which coincide with three similar projections inside the piece, A, so as to lock the slide, B, which closes the breech of the barrel, at the moment of exploding the cartridge. The piece, I, is furnished with two internal grooves, *i*, serving as stops for the spring, H, and terminates in a six-sided portion which receives the head of the lever or key, J. In figs. 3 and 4, K is the brass elevator which causes the cartridges to pass in succession from the magazine, X, contained in the stock, into the slide, B. This elevator is provided internally with projections, *u*, which facilitate its adjustment in position, and permit it to slide vertically inside the piece, A. It has formed in one of its sides an opening, *l*, which admits of the introduction of the cartridges into the magazine, X. It is also provided on its two internal sides with projections for the purpose of holding the empty cartridge cases withdrawn from the barrel by the extractor, and of preventing the full cartridges from being thrown out when being rapidly elevated. At the rear end of the elevator the projections no longer exist, in order that the empty cartridge may assume an oblique position in turning over for the purpose of escaping by their own action from the hook of the extractor. A bell-crank lever, of which the extremities move in the opening, *o*, of the elevator, and in the groove, *f*, of the slide, B, brings the elevator to the level of the barrel, Y, when the slide, B, is entirely withdrawn from the breech of the barrel. In order to lighten the elevator, K, a chamber, *q*, is formed therein, closed by a flat portion, which during the movement serves to hold back the cartridges in their magazine, X; the small arm of the bell-crank lever being only acted upon by coming in contact with the extremities of the groove, *f*. The elevator is maintained in its elevated position by the friction of a spring fixed to the trigger-guard, U. The lock, N, is hinged at *r* to the piece, A, and has formed on it at *s* a hammer-head or striker, of which the upper surface, *t*, is roughened, as shown, so as to be readily seized by the thumb. The lock is formed also with a projecting part, *u*, which completely closes the slot in the piece, A, in which it moves. The lower part, *v*, of the cock is curved to receive the action of the main spring, P, by means of the link, O, to which it is jointed at X, and of which the two branches, *y*, rest in the curved parts, Z, in the free end of the spring, P. The cock, N, further carries a stop, Q, which is supported by a spring, R, and which is intended to prevent accidental discharge of the arm by coming in contact with the solid portion of the head of the lever, J. A notch is made in the head of the lever, *j*, so as to allow the stop, Q, to pass when the slide, B, is locked in its place in the breech of the barrel ready for firing. The object of the spring, R, is to bring the stop, Q, in contact with the head of the lever, J. The stop Q, as well as the notch, is inclined or bevelled on one side, so that the first movement imparted to the lever, J, forces back the cock a certain distance, and the slide, B, in moving back, completes the full cocking of the arm. The link, O, has the effect of varying the length of the arm of the lever in an inverse ratio to the tension of the spring, P. The trigger, S, is kept in contact with the cock by a spring fixed to the piece, A, which spring may be in one piece with the spring, P, before referred to. The magazine is, as will be seen on referring to figs. 3 and 4, closed by a metal tube inclosing a helical spring, which constantly urges forward the cartridges into the elevator. The following is the mode of using this improved repeating fire-arm. When the arm has been fired, the lever, J, must be raised about one-sixth of a revolution, in order to unlock the slide, B, which is then drawn back; the extractor draws with it the spent case, and the bell-crank lever, L, of the elevator, K, causes the latter to raise a fresh cartridge to the axial line of the barrel. The cartridge thus elevated is forced into the breech of the barrel by pushing forward the slide, B, which is then secured by depressing the lever, J. The arm is now ready for firing in the usual manner. In the meantime a fresh cartridge has entered the elevator from the magazine, and the extractor has seized the flange of the cartridge-case, which, after having been exploded, is withdrawn like the preceding one. In case the lever, J, has not been lowered to the position of safety, the cock will be arrested by the stop, Q, and the striking of the cartridge cannot therefore take place accidentally.

Fig. 3.

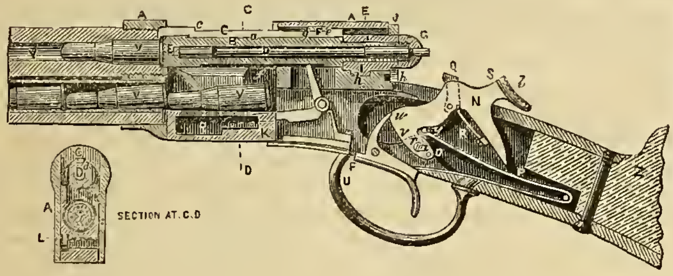


Fig. 4.

Figs 5, 6, and 7 represent a longitudinal and two transverse sections of fire-arm, an arrangement analogous to the one previously described, but in which the parts for producing repetition are not employed. All the other parts, whether movable or fixed, are similar to and are indicated by the same letters as the parts represented in the preceding figures.

Fig. 5.

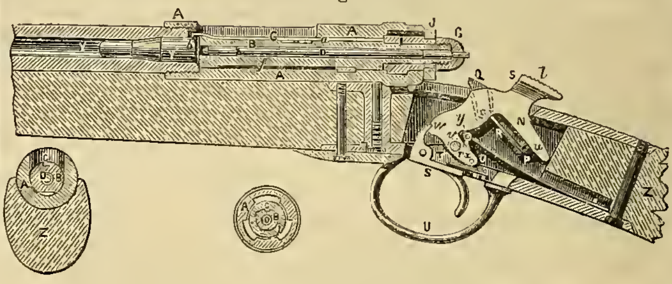


Fig. 6. Fig. 7.

IRON AND STEEL.

J. A. Jones, *Middlesborough.—Patent dated February* 5, 1868.

This invention relates to certain improvements in the production of iron and steel from cast or pig iron, and consists in melting cast or pig iron in a reverberatory or other melting furnace, and, after fusion, agitating the same, and then, having by preference lowered the damper of the furnace, adding to the melted metal a flux consisting of oxide of manganese, common salt, sal ammoniac, or any of them together, with spiegeleisen. After agitation, and when the ingredients beforementioned shall have been incorporated with the molten metal, the damper is to be raised, and the charge or contents of the furnace are again rendered fluid, so as to enable the separation of the cinder or slag from the resulting metal to be effected. The cinder is then tapped and run off, and the crude iron or metal is removed from the furnace and melted into steel, either on the open hearth of a furnace or in a crucible. The puddling furnace preferred to be employed may be similar to those at present in use, or it may be specially constructed so as to produce a larger quantity of material, or it may be constructed of such other form as may be well adapted for the successful carrying out of my improved process.

It is preferred to fettle the sides and bridge of the furnace with oxides of iron, such as hæmatite ore, Swedish ironstone, or mill tap cinder, which materially assist in effecting the cleansing of the iron from certain impurities, such, for example, as sulphur and phosphorus, which impurities, as is well known, are injurious to the quality of iron or steel to be produced. Slag, and by preference that known as hammer slag, is placed among the pig or cast iron in order, when melted, to form a bath in which the iron may be washed. This is not absolutely necessary, but it materially assists in effecting the purification of the iron. The pig or cast iron, together with the slag, is placed in a furnace and is therein melted, and after having been well puddled, agitated, or stirred, the damper of the furnace is closed; or, in place of the pig or cast iron being melted in the puddling or operating furnace, it may be melted in a cupola, or air, or other furnace, and thence run into the puddling furnace to be operated upon, thus saving time and fuel. When the damper has been lowered as before described, to the mass is added, in either case, a mixture comprised of the following ingredients: viz., oxide of manganese, common salt, sal ammoniac, spiegeleisen, and ground charcoal.

The proportions which have been found to give good results are, to a charge of 4½ cwts. of pig or cast iron, about—

1½ lbs. of Manganese.
4 " Common Salt.
¼ " Sal Ammoniac.
¼ cwt. of Spiegeleisen.
½ lb. of Charcoal.

In addition to these, iron ore, such as hæmatite, may be added, either in lumps, or ground small or fine. About 50 lbs. to the charge of 4½ cwts. of pig or cast iron is found advantageous. These proportions may be varied, and any of the ingredients may be omitted if desired. The molten iron, together with the flux or fluxes which have been added thereto, is now agitated, stirred, or again puddled, after which operation the damper may be raised and more heat applied, until the cinder becomes more liquid, and the grains of crude iron have aggregated and have settled to the bottom of the furnace. The cinder or slag may then be tapped off from the crude iron or metal, and the latter may be removed from the furnace and may be plunged hot into water. Previous to the crude iron being plunged into water, it may be pressed, tilted, or hammered, so that a portion of its cinder may be removed. It may sometimes not be absolutely necessary to flux all kinds of pigs or cast iron as described, nor to line or fettle the furnace with oxides of iron, but such a flux or fluxes as described, together with oxides of iron, tend to purify the iron or metal, and to render it more suitable for subsequent melting into steel. The crude iron or metal resulting, as before described, having been removed from the operating furnace, and, if required, submitted to pressure or hammered, so as to remove a portion of its cinder, and then plunged into water, is now to be gradually heated to a red or white heat, and placed by degrees in the open hearth of a steel-melting furnace, such, for example, as Siemens' furnace, as at present constructed for melting steel on the open hearth, or on the hearth, or in crucibles placed in other furnace or furnaces capable of melting the same into steel.

A small quantity of cinder is placed on the hearth of the steel-melting furnace, which may be made from sand, lime, and salt melted together, or blast-furnace slag may be used. This will act as a protective covering to the iron or steel, as well as forming a bath into which the first few loads or charges of the crude iron or metal is placed, or the bath may be composed of cast iron alone, or in conjunction with the slag or cinder. This cinder, or a portion of it, may, as the charging of the furnace continues, be allowed to run off the steel, or if there be so much as to incommode the working of the furnace, it may be tapped away.

When the crude iron or metal is melted, the quality and temper of the product can be ascertained by taking out a portion from time to time and testing it by smithing, or otherwise, as is well understood. If the steel be found too soft, cast iron may be added to harden it, and if too hard, it may remain for a longer time in the furnace, or wrought iron or scrap may be added. The crude iron or metal may be made to contain variable proportions of carbon, but it is preferred to work it in the first operating furnace, so that it may contain about 1 per cent. With this percentage of carbon in it, it will not, under the influence of the ordinary temperature of a puddling furnace, remain in a liquid state, but will settle to the bottom of the furnace in the form of a pasty and porous mass. In this state it would be unfit for being balled or hammered into wrought iron, on account of its not having "come to nature," but it is suitable for being melted into steel.

As each load or charge of the crude iron or metal is added to the charge in the steel furnace, it will convey carbon to the mass about sufficient to compensate for the elimination of carbon which more or less results from open hearth melting; and when the furnace is charged, and it has been ascertained that the steel is fully melted, at the latter end of the process is added a small quantity of spiegeleisen, or ferro-manganese, in quantities not exceeding 5 per cent. of the melted steel. A flux may be used in the steel-melting hearth, such as oxide of manganese, lime, and salt, and alloys may be added, such as those of titanium or wolfram. The melted steel when ready is tapped out direct into ingot moulds, or into an intermediate receptacle and thence into ingot moulds. The moulds may be fixed on a carriage, which is pulled up to the tapping hole by means of gearing. In the interval a plug of clay or iron may be placed in the tapping hole. The hereinbefore-described process is adapted for the treatment of various qualities of cast iron or pig iron, but more particularly to that class which contains elements such as sulphur and phosphorus, and unless their entire or partial removal is effected, the quality of the steel produced will be materially impaired. In carrying out this process it is preferred that the crude iron or metal, previous to its being placed on the melting hearth, should be heated in a chamber, by preference one connected with the steel furnace. The hearth of the steel furnace may be lined with a material suitable for withstanding the high temperature, such as sand, or with best qualities of fire clay or brick, or other refractory materials.

LAMPS.

R. W. Park and J. C. & W. H. Love, *Philadelphia.—Patent dated 26th March*, 1868.

This invention relates more particularly to certain improvements in, and modifications of, the burners or mounts of lamps intended for the burning of paraffine and other liquid hydrocarbons, whereby increased brilliancy of flame is obtained, a better form or shape of flame is produced, which enables a plain cylindrical chimney to be used in lamps having flat wicks, and greater facility of access to the wick is afforded. According to the first part of this invention it is proposed to employ in the said burners, a flat, or nearly flat, slotted plate, situate a little above the ordinary dome; such dome being, moreover, surrounded at the sides by a pendent hollow cylinder or casing, an annular space being left between the said hollow cylinder and the dome for the free passage of air, which is so directed on to the flame as to increase considerably the brilliancy thereof, and make it longer and narrower, so as to admit of the use of a cylindrical chimney.

The second part of this invention consists in combining with the dome of the burner two air tubes, channels, or orifices, arranged one at each end of the elongated slot in the dome, so as to direct the air into a course which will produce the same effect on the flame as that caused by the first part of this invention.

The third part of the said invention consists in making the perforated casing of the burner in two parts, an upper and a lower, and in providing one of such parts with elastic metal lips or tongues, so adapted to the other part that when inserted therein the two parts will be held securely together, whilst at the same time, by a slight effort, they may be readily separated. The upper part contains the dome, with the flat, or nearly flat, slotted plate and the pendent cylindrical casing, or the air-tubes or orifices at the ends of the slot, as the case may be; whilst the lower part contains the wick-tube and elevator.

Fig. 1.

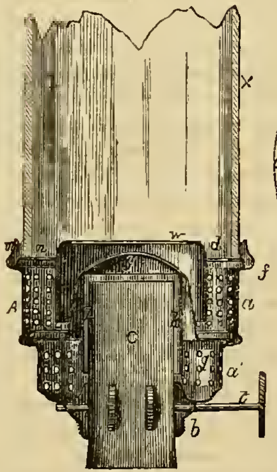
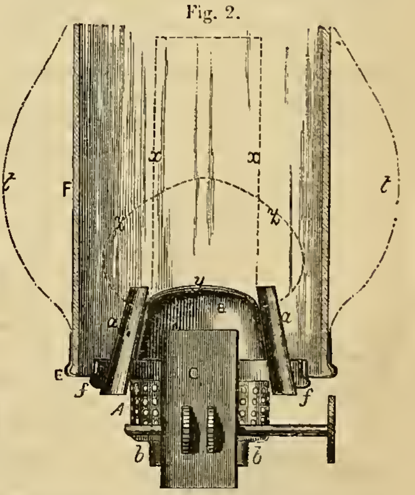


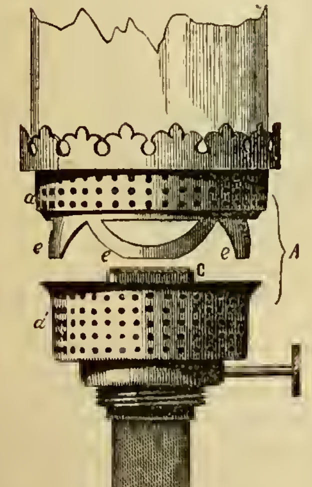
Fig. 2.



On reference to the first part of this invention, illustrated in fig. 1 of the engravings, A is a cylindrical perforated casing, at the lower end of which is the usual screw projection, *b*, adapted to the screw-top of the fountain or oil reservoir of the lamp. The upper portion, *a*, of the casing, A, is larger in diameter than the lower portion, *a'*, and on the shoulder, *x*, formed by this contraction of the casing, bears the edge of the horizontal flange, *q*, of the dome, B; the elongated opening, *y*, of the latter being directly above the wick-tube, C, which extends through and is secured to the lower end of the burner. Above the dome is a horizontal plate, *d*, the central elevated portion of which has a flat top, *w*, and in the latter there is an elongated opening directly above and coinciding with that in the top of the dome, B; the edge of the said plate, *d*, rests on a ledge, *f*, formed on the inside and near the upper edge of the perforated casing, A. On the under side of the plate, *d*, there is a hollow cylindrical projection, *i*, which extends to within a short distance from the flange or base, *q*, of the dome, and partly covers but is not in contact with the said dome. The wick-tube, C, is surrounded near its upper end with a flat tube, *k*, and between the latter and the wick-tube a space is left through which the air admitted to the perforated casing, A, can pass upwards freely. In the flange, *q*, as well as in the sides of the dome, there are small holes, but they are not absolutely essential; and holes, *n*, are also made in the plate, *d*. A rim, *m*, is formed on the upper edge of the casing, A, for retaining the cylindrical glass chimney, X, and through the lower end of the casing passes a spindle, *t*, provided with toothed wheels which project through slots in the wick-tube, so that by operating the spindle the wick can be raised or lowered at pleasure. Repeated trials have proved that a slotted plate, *d*, flat, or nearly flat, at the top, and arranged in the burner in the manner described, has not only the effect of increasing the brilliancy of the flame, but causes it to assume such shape and dimensions that a plain cylindrical chimney can be used in place of the ordinary chimneys, which are swelled near the base, as shown in the dotted lines, *l*, *l*, fig. 2, in order to accommodate the expanded flames of common lamps, and which are of so fragile a character as to be easily broken. It has also been found by repeated tests that the pendent casing, *i*, suspended over and surrounding the dome, B, increases the brilliancy of the flame, as it serves to direct a plentiful supply of air to the point where its action on the flame will produce the best results.

Another mode of contracting the flame so that a cylindrical chimney can be used, and the illuminating quality of the flame increased, is shown in fig. 2, which illustrates the second part of the invention. In this view, A is the perforated casing, to the lower end of which is secured the wick-tube, C, the casing having the usual screw projection, *b*, for attaching the burner to the fountain or reservoir of the lamp; the perforated casing, A, terminates at the top in a projecting flange, *f*, through which pass, and to which are secured, the two air-tubes, *a a*. The dome, B, and plate, E, for supporting the chimney, are in the present instance made in one piece, a recess being formed beneath the plate for the reception of a portion of the flange of the perforated casing, A. Different modes may, however, be employed of so fitting the plate, E, to the said casing, that the former may be readily detached from the latter, and access thereby be had to the wick when it requires trimming. The two air-tubes, *a a*, pass through openings in the plate, E, and are so arranged that one tube is adjacent to one end, and the other to the opposite end of the usual elongated slot, *y*, in the dome. These air-tubes, instead of being secured to the flange, *f*, of the perforated casing, may be secured to the dome plate, E, care being taken, however, that there shall be a free admission of air to the tubes from below. The effect of the two currents of air is to contract the flame and increase its height and brilliancy; the flame having parallel, or nearly parallel, edges, as shown by the dotted lines, *x x*, instead of the usual wide flame of limited height shown by the dotted lines, *z z*. This permits the substituting for the cumbrous chambered glass chimney, a cylindrical chimney, F, which is cheaper than, and not so liable to become broken as, the swelled chimney. The currents of air from the tubes, *a a*, intervening between the edges of the flame and interior of the chimney, maintain the latter in a comparatively cool state. In place of the air-tubes, simple openings may be made in the plate, E, and corresponding openings in the flange, *f*, of the perforated casing, A, for admitting air from below at such points that it will pass upwards in two currents, one near one end, and the other near the opposite end, of the elongated slot in the dome. The use of the air-tubes, however, is preferred, as they insure more certain and defined currents of air directed to the proper points.

Fig. 3.



The third part of the invention is illustrated in fig. 3. The perforated casing, A, instead of being made in one piece, consists of the upper and lower portions, *a* and *a'*, to the former of which is fitted the cylindrical chimney, the slotted dome, and above the latter the flat slotted plate, or the air-tubes described above, for contracting and increasing the brilliancy of the flame. To the lower portion, *a'*, of the perforated casing is secured the tube, C, containing the wick, which, on detaching the upper portion of the casing and its adjuncts, is exposed and can be easily trimmed. Any desired number of pendent elastic lips, *e e*, form a part of, and project from, the under side of the upper portion, *a*, and are bent slightly outwards. The lower portion, *a'*, of the casing is slightly contracted towards the upper edge, where it is of such a diameter that the elastic lips, *e*, cannot be inserted into it without a slight effort, and without the yielding of the lips, *e*, which, however, recoil when inserted into the lower portion of the casing, and retain such a hold of the inclined interior of the same, that an effort is necessary to withdraw the upper from the lower portion of the casing.

WEFT WINDING MACHINERY.

Messrs. Thomson & Gall, *Dundee.—Patent dated 3rd March*, 1868.

This invention, which relates to an improved arrangement or construction of machinery for winding weft, and of mechanism by which the spindles are stopped when the pirns or cops are fully built up, consists in placing a fast and loose pulley on each spindle, whereon a pirn or cop is formed; both of the pulleys are free to move endwise on the spindle. The spindle is also free to move endwise in its bearings while being driven, this endwise movement being provided for by forming a groove in the spindle, into which a key or feather passing through the driving pulley is fitted. As the pirn fills, the spindle is gradually pushed upwards; but the driving pulley still remains in the same position relatively to the driving belt, until the "driver," which is placed on the end of the spindle, presses against a sliding bracket, to which a weighted lever is connected. The pulleys are kept together within the tails of the sliding bracket. As the bracket is pushed upwards by the pirn, or up as it is formed, the weighted lever assumes a perpendicular position; and when it has passed the vertical point it suddenly falls over, drawing with it the sliding bracket and pulleys, so that the fast pulley is drawn from under the driving belt, and the slack pulley is passed under the belt, thereby causing the spindle to stop. The yarn may be drawn either from a bobbin or reel, the traverse motion being given by means of a crank in the driving cylinder shaft, or by means of a pinion keyed on the cylinder shaft, actuating a wheel provided with a crank pin.

Fig. 1.

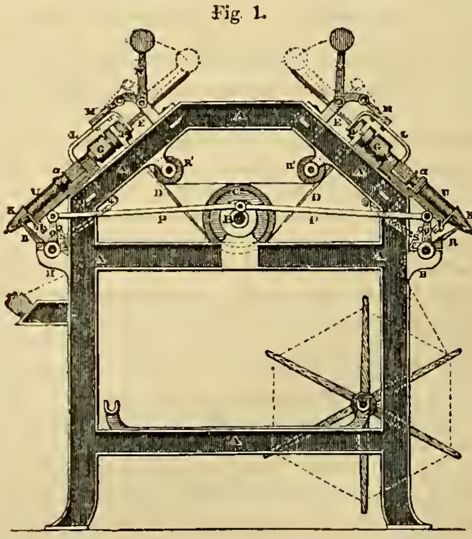
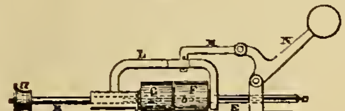


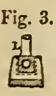
Fig. 1 of the engravings is an end elevation of a spindle frame for winding weft off reels and bobbins into pirns or cops, as used in the manufacture of textile fabrics. The framing, A, is of the usual open rectangular order, but having the upper part inclined on both sides, as shown at A′ A′. On these inclined parts the spindles, E, are carried, as shown and hereinafter set forth. Along the central part of the framing the driving shaft, B, is carried, on which the spindle-driving pulleys, C, are placed, over which the belts, D, pass, which actuate the spindle pulleys, F and G. On either side of the framing, brackets, H, are placed, to which other brackets, I, are attached; these carry the hollow cone, K, and the spindles, E, pass through a hole in the lower and smaller end of the cone. The upper part of the spindle passes through bearings in the two tails of the sliding bracket, L, and the sliding bracket, L, is connected by the link, M, to the weighted pressing and tumbling iron, N. On the central shaft, B, a crank, O, is fixed, for actuating the reels, P, which are connected to and actuate the traverse lever, Q, and finger, R, by which the yarn is laid on the pirns or cops, S, as they are being built up. A spindle and gear for actuating the same are shown more distinctly on the enlarged detailed pirns, figs. 2 and 3, where the long slot or groove in the spindle, E, is also shown to raise the feather or key on the driving pulley, F.

Fig. 2.



The mode of operation may be described as follows:—The yarn to be wound is brought either on reels or bobbins, as shown respectively at the left and right hand sides of fig. 1. It passes thence over the "uptake" lever, S, which is actuated by a spring, T, so as to keep a constant degree of tension with yarn ascending to the position of the traverse gear. On leaving the lever, S, the yarn passes through an eye in the end of the traverse lever, R, from which point it is led to the pirn or cop, U, by passing through the large inclined slit made in each of the cones, K, as shown at fig. 1. As the pirn or cop is built it pushes the spindle, E, upwards, until the driver marked *a* on each spindle comes into contact with the lower tail of the bracket, L. Thus, as the building proceeds the weighted lever, N, is thrown from an inclined into a vertical position, as soon as it gets beyond which its weight throws it over and causes it to assume the position shown in dotted lines in fig. 1; and as the lower tail of the bracket, L, bears against the pulley, G, it is evident that at the same instant the weighted lever falls into the position last mentioned, each of the pulleys, F and G, are carried upwards along the spindle, E, whilst the driving belt is not altered in position; therefore the loose pulley, G, is brought into contact with it, whilst the fast pulley is separated from it. The revolution of the spindle being thus stopped, the pirn or cop, U, may be "stopped" by the attendant, and the operation of building another pirn or cop proceeds as hereinbefore described.

Fig. 3.



It is to be understood that the preceding description, although confined for the sake of simplicity to one spindle and its accompaniments, is not intended to apply to one such spindle only in practice, as any convenient number of them may be adopted. The spindles may also be placed in a horizontal or vertical position as well as inclined, as shown in the engravings, and the groove, *e*, in the spindle, E, fig. 2, may be cut spirally on the spindle so as to give a smoother sliding motion.

FERMENTED LIQUORS.

Michael Rowand, *Lewisham.—Patent dated 13th March*, 1868.

This invention has for its object the solidifying and preserving of hops and malt, or their extracts, or hops alone, with glucose or grape sugar, whereby a solid compound substance is obtained, which will keep in a sound state for any length of time and in any climate, and may be used when required for the manufacture of good and wholesome malt liquors. According to this invention, it is proposed to mix or incorporate the malt and hops, or extracts thereof, with saccharine fluid, prepared from the sugar obtained from sago flour, or some other farinaceous substances, and which is commonly known as glucose or grape sugar; and also to use sometimes the substance known as "Garton's Patent Saccharum," or brewers' sugar, described in the specification of letters patent granted to Charles Garton, bearing date February 18, 1859, No. 451—such saccharum being used in combination with the glucose or grape sugar syrup above referred to; and, if required, cane sugar, golden syrup, treacle, or molasses, may be added together or separately, according to the different qualities of malt liquors to be manufactured. It is also proposed in some cases to dispense with the malt, as the glucose or grape sugar and the hops will answer the purpose.

In carrying out the invention, the grape sugar is reduced to a syrup by melting the same in a steam-jacketted pan, or other heater or copper, and then (when malt is intended to be employed) adding thereto the malt either in a bruised or pulverized state, a considerable portion of the husk in the latter case being removed. This mixture is raised to a temperature of from 140° to 200° Fahr., and maintained at such temperature for a period of from twenty minutes to half an hour. The steam is then turned off from the heater or pan, and the hops or extract of hops added, the proportion depending upon the nature of the beer to be manufactured. When malt is not used, it is unnecessary to raise the temperature of the syrup to so high a degree as above mentioned. The whole of the ingredients are then thoroughly stirred and well mixed together, after which the mass, which will by this time have assumed a pasty consistency, may when sufficiently cool be compressed and packed into tins or receptacles for the market. It is obvious that the proportions of the ingredients in this improved solidified compound may be varied according to the quality of the beer to be brewed. For strong ale or stout, it is found that nine pounds of malt, and an equal weight of the grape sugar mixed with about eight ounces of hops, will give a good result, such proportions being sufficient to brew nine gallons of ale. For lighter ales or porter, the proportion of water should be increased. When stout or porter are required, it is preferred to use what is known as black malt.

IRON AND STEEL.

Charles Attwood, *Walsingham.—Patent dated 10th March*, 1868.

This invention of an improved method or methods of making cast steel, and of making iron of a steely character, which is called steel-iron, as being a kind of iron approximate to steel, consists as follows:—The material employed may consist of such metal, whether in the state of iron or in that of steel whilst still in the melted state, as may have been previously brought out of the state of non-malleable or crude cast iron into such a degree of decarburization as to have become malleable, by the means of blowing through it or into it whilst in a melted state a blast or current of atmospheric air, according to the process well known to metallurgists by the designation of "the Bessemer process;" or which may have been brought into such a condition by any other means of applying either atmospheric air or other substances containing oxygen to such crude metal in the melted state, either beneath the surface or otherwise; and crude cast iron or non-malleable iron, either in a melted or in a heated state, or otherwise, if in any case more convenient, in either a heated or in a cold state—which ingredients are mixed together in the hollow or excavated hearth or bottom of a suitable reverberating furnace, in such manner or manners as hereinafter described, and in such proportions as under a very high and sufficiently continued heat may bring the whole mass, while in a state of fusion, to the proper chemical or metallurgical condition or quality of such descriptions of hard or soft steel, or of steel-iron (or steely-iron), respectively, as it may be intended to produce; after which the furnace is tapped, and the metal drawn off, either directly into ingots or other moulds, or indirectly by tapping it previously into ladles, as may be found in any case more convenient.

As regards the kind of reverberating furnace to be thus employed, it is found that though a furnace similar to the common iron-founders' reverberating furnace, heated by coals burning upon the usual kind of grate, is capable of giving sufficient heat to so liquefy or hold in liquefaction the said mixture; yet inasmuch as the obtaining and maintaining a higher and more uniform temperature, and by means of a flame more free from ashes and from sulphur than from such furnaces and grates can be obtained, and also insomuch as no considerably greater quantity of oxygen should pass into or through the melting chamber than may be readily for the most part absorbed or consumed by the carbonaceous or other gases of the furnace, it is preferred to employ a furnace heated by the combustion of gases, such as carbonic oxide or carburetted hydrogen, or other hydrocarbonaceous matters, according to any known or suitable method of employing them in furnaces; and the sort of furnace well known and used for steel melting called the "Siemens' Regenerating Furnace" is found to be very suitable and effective for the purpose, although the same result may also be obtained by other furnaces and other modes of burning such or similar combustible gases, such as persons skilled in such operations may preferably construct and employ. The furnaces must have a tapping hole, which may be similar to such as is usually used in ordinary iron-founders' reverberatories, and which may best be placed at or about the middle or deepest part of the excavated sole or hearth thereof, and so that it may be stoppered up in any manner usual or convenient in such furnaces. There must be also openings at which to run in or charge the fluid, or solid metals or materials which may be employed, and for taking out such small quantities for testing as may be desired, which openings should be so constructed as to be well and speedily closed and luted up after using them.

The hollowed out or excavated hearth of the reverberating chamber must be of such size and depth as the quantity of metal intended to be cast from each separate melting may require, and may contain either small quantities of, say, 3, 4, or 5 cwts. of metal, or as much as 3, 4, or 5 tons or more, according to the size of the ingots or other castings required, the time required for working off a charge of such large quantities being of course longer than in the case of smaller; but for which smaller quantities from one to three hours will generally be amply sufficient. The brick or stone work or foundation of the hearth should be covered, as usual in iron-founders' reverberatories, with silicious sand in a moderate degree ferruginous, or better still with rather coarsely ground "ganister," well rammed down to a considerable depth or thickness of somewhere about 18 inches; which also may advantageously be itself covered to the thickness of from 6 inches to 1 foot with an upper layer of the same sand, or of ganister, which may preferably be ground and mixed to the extent of about one-eighth of its weight with a somewhat fusible sort of sand, or loam, such as is well known to and used by iron-founders, by the name of "Woolwich loam." The inside walls and the arch or crown of the furnace may advantageously be made of "ganister bricks," or of the sort of bricks called "dinas bricks."

The proportions in which the two kinds of metal are to be used must vary according to the degree in which the malleable metal is used, as the material may have been previously more or less completely decarburized, or brought into the state of hard or soft steel, or of hard or soft iron; but by way of general rule, it may be mentioned that in any case in which that decarburization may exist to about the same degree to which it is usually carried in well-puddled bar iron, a mixture of crude or cast iron therewith, in the proportions of about from 8 to about 15 per cent. of the total or mixed mass of metal, will yield a more or less soft or hard steel-iron; whilst the mixture of such crude metal in the proportion of from about 15 to about 40 per cent. of such total mass, will give either such a soft or such a hard steel as may be suitable for most of the various purposes for which steel is generally employed.

As regards the mode of mixing the materials, it is preferred that the crude or non-malleable metal which may be employed should be melted in the reverberating furnace itself before the addition of the other material; though otherwise it may, where more convenient, be conveyed into the said furnace out of some other furnace or vessel whilst in a melted state, and in either case it should be brought to a state of liquefaction before the addition of the decarburized material. And inasmuch as it may sometimes be convenient for purposes of economy, or otherwise, to add to these materials in the reverberating furnace a greater or less proportion of steel, or of such steel scrap as it may be desired to work up and bring into the state of cast-steel ingots; such addition may be made either by adding it to or liquefying it at first along with the crude cast iron, or else by mixing it with the other materials, and it may either be added in the cold or in the melted state to the metal in the furnaces.

It is usual in the practice of what is called "the Bessemer process" to first decarburize the iron, and then to add to it while in the converter, and still fluid, as much crude metal, also in the liquid state, as is judged sufficient for converting it to steel. And in that state those mixed materials in the state of steel may then be passed into this furnace and brought, by continued liquefaction, either with or without commixture with a further quantity of either crude metal or decarburized iron, as may be necessary, to such a condition in respect of quality or hardness as may be desired. It is considered more convenient, however, not to previously make such mixture with crude metal in such converter, but to pass the metal, decarburized as nearly as may be to the same degree as is the case with well-puddled bar iron, into the reverberating furnace as soon as that degree of decarburization may be arrived at; when the required proportions of crude and of decarburized materials will mix and combine more perfectly at the high and continued temperature which can be maintained therein than they usually do in the said converter: the value of this process in great degree consisting in the much more uniform quality to which the steel or steel-iron can thus be brought, and in the more homogeneous and sound quality of the castings than can be obtained when cast directly from the Bessemer or any other converters. Nevertheless, in cases where such mixture of decarburized and crude or non-malleable metals may have been actually made in such converters or converting vessels, or in cases where by nature of any other process or processes of decarburization which may have been employed, the metallic results may have been brought into a similar state of steel or of steel-iron, as the case may be, the contents may still be transferred into the reverberating furnace; in which furnace, either with or without such mixture with crude or non-malleable iron, or with decarburized iron, as may in any particular cases be as before said necessary, it may be continued sufficiently long for combination or for settling out the bubbles of gas or air, and then be cast into sound and homogeneous ingots or castings of the quality and in the form required. But in every case the quality of the metal to be produced will be better or worse according as the metallic materials employed may be such as, by their own proper quality and nature, are capable of producing steel and steel-iron of better or worse quality when used for such production by the more usual processes of manufacture employed for that purpose.

IMPROVED WINDOWS.

James Wood.—*Patent dated 16th January*, 1868.

This invention relates to an improved construction of windows, whereby the window sashes or frames may be conveniently removed from the cases for cleaning the glass panes, or other purposes. It consists essentially of a metal box, bracket, or guide, fixed to the window case at about the height of the centre of the top frame, and in the line of the ropes of the lower sash. This bracket or guide is constructed with flanches between which the rope runs, and these are of such depth that the groove in the lower frame may pass over them. Attached to the bracket is a lever, projecting far enough to allow the window lines to pass behind it, the lever being actuated by an arm which is pressed upon by the batten rod of the window; when the batten rod is removed and the lower frame taken out, the rope which is attached to a hook in the frame is removed, and the lever which is attached to the box bracket prevents the weights from running down. The parting rod, instead of being made in one piece as at present, is made in three pieces; the upper and lower piece are fixed; but the central piece, which is a little longer than the height of the top sash, is hinged on the inside of the window case, so that it can be pushed in to the case and allow the window frame to fold down inside of the window. This is effected by fixing a metal bush a short distance from the wooden sill; in the bush a circular hole is formed, and a slit made on the top side, to admit an oval or oblong pivot, which is attached to the bottom of the sash. When the sash is lowered, the pivot enters the circular opening in the bush, and acts as a hinge on which the window is folded down to the inside. To prevent the noise occasioned by the sashes when subject to the action of wind or other causes, spiral springs, covered with leather or other substance, are inserted into the outer side of the sashes; these press against the case, so that the sashes are continually forced inwards, and the recoil of the window when acted upon by the wind is prevented.

Fig. 1 of the engravings is an elevation of a window from the outside with the facing removed, for the purpose of showing the hanging cords and weights; the lower sash is also shown partly in section. Fig. 2 is a vertical transverse section of the window case. The woodwork of the sashes, A, is constructed in the usual manner, with this exception, that instead of forming grooves in the styles of the upper sash for the sash lines to fit in, that part of the style in front or outside of the cord is cut out, as shown at *a*, fig. 1. According to the manner in which sash windows are hung at present, great inconvenience attends the operations of cleaning, painting, and glazing them, as the sashes cannot without difficulty be removed from the window case, there being no means of detaching the sashes from the cords by which they are suspended. One part of this invention consists, then, of an improved method of hanging the sashes, so that they may be conveniently removed from the cases for cleaning, painting, glazing, or other purposes. This is effected by fixing a bracket, B, figs. 2 and 3, to the breast of the window case, C, in the line of the cord, D, by which the lower sash is suspended, the cord, D, being made to pass through a bracket, B. A lever, E, is fitted in the front of the bracket, B, from which an arm, F, passes under the batten rod, G, so as to keep the lever, E, in the position shown in fig. 3, allowing the cord, D, to pass up and down freely through the box bracket, B, when the sash is raised or lowered. The grooves in the styles are formed sufficiently large to allow the sash to pass over the box bracket, B; and the cords, D, fig. 1, are attached to the sash, A, sufficiently far down, so that the sash may be raised to the top of the case without interruption. When the lower sash is to be removed from the window, the screw, *e*, fig. 2, in the batten rod, G, is released, and the batten rod, G, is removed. The arm, F, of the lever, E, is now free, and the lever, E, is turned to the position shown dotted in fig. 3, and the cord, D, is pressed into the curve formed in the back of the box, B, as shown in same figure. The sash, A, is now removed from the case, C, and the cords, D, are detached by pressing back the spring, *d*, and unhooking the link, *b*, from the hook, *c*. The whole pressure of the balance weights, *f*, now act upon the cords, D, and as the centre of the lever, E, is placed a little above the centre of the curve in the back of the box, as shown in fig. 3, the cords are wedged in so that the weights cannot run down. When the sash is replaced the lever, E, is lifted up and the batten rod replaced over the arm, F, which prevents the lever, E, from falling down as hereinbefore described. Another method of supporting the balance weights, *f*, while the sash is removed from the case, is shown in fig. 4. In this case the cords are pressed outwards against a box, *g*, by a lever, *h*, fixed on a spindle, *i*, turned by the screw, *j*, gearing into the pinion, *k*. The screw, *j*, is covered by the batten rod, G, which must be taken out before the screw, *j*, can be turned. The pin, *l*, prevents the lever, *h*, from being turned too far round. The upper sash is constructed to fold down to the inside, after the under sash has been removed. To effect this an oval pivot, *m*, fig. 1, is screwed near to the bottom of each style of the upper sash, and near to the bottom of the case. A metal bush, *n*, fig. 2, is screwed to the breast, C; when the sash is pulled down the pivot, *m*, enters the bush by a notch formed in the top of the bush, *n*, as shown in fig. 2, and forms a hinge upon which the sash turns. To allow the sash to be turned inwards the parting rod, *o*, is made in three pieces, as shown in fig. 2; the pieces at top and bottom of the case are fixed in the usual manner; but the centre piece, *p*, is hinged to the piece of wood, *q*, which is also hinged to the piece, *r*, which fills the "pocket hole" in the breast, C, as shown in fig. 5. The breast, C, is cut through behind the piece of the parting rod, *q*, so as to allow it to be pushed back. Fig. 5 shows the position of the centre piece of the parting rod, *p*, when the sash is in its normal position. A pin, *s*, is fixed on the batten rod, G, which presses against the tongue, *t*, and keeps the parting rod, P, out. When the sash is to be folded down, it is lowered till the pivot, *m*, enters the bush, *n* (it being understood that the lower sash has been removed); the piece of the parting rod, P, is now pushed back into position, and the sash is turned round upon the pivot, *m*, in the bush, *n*. To prevent the noise occasioned by the shaking of the sashes when subject to the action of the wind or other causes, spiral springs may be inserted into holes, bored in the sashes, as shown at W, fig. 1. The springs press against the case, so that the sashes are pressed inwards, and the recoil of the window when acted on by the wind is prevented. The hole in which the springs are placed may be covered with a piece of leather or other soft material, to keep the spring in its place when the sashes are removed from the case, and also to prevent the springs tearing or rutting the case. To assist the sash in moving up and down smoothly, small rollers may be fitted in the sash opposite to each of the springs, W, fig. 1; or the springs may be fitted in behind the rollers, and the rollers thus pressed against the case, so that no leather or other covering will be required.

Fig. 1.

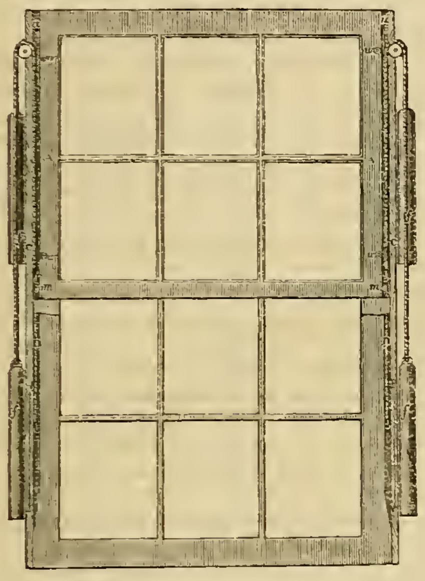


Fig 2.

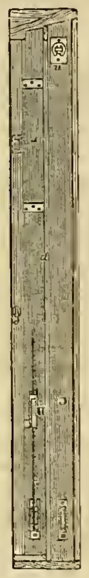


Fig. 3.

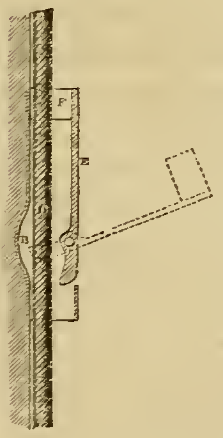


Fig. 4.

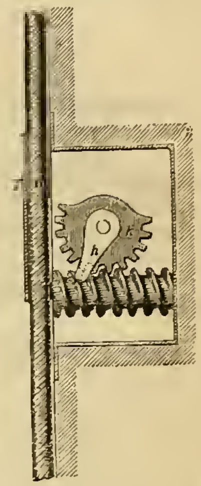
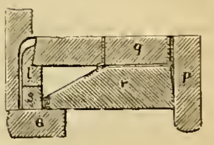


Fig. 5.



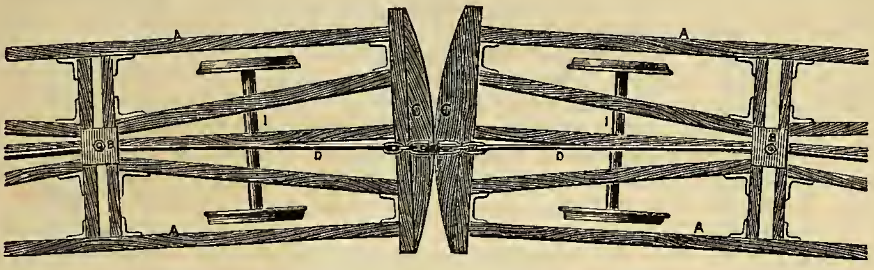
RAILWAY CARRIAGES AND WAGGONS.

R. F. Fairlie, *London.—Patent dated* 22*d April*, 1868.

This invention relates to a peculiar construction and arrangement of railway carriages and waggons, and to an improved mode of coupling them together, to form a train whereby friction is considerably reduced, unpleasant shocks are avoided, the length of the train for a given quantity of passengers or goods is shortened, and other advantages are obtained.

The engraving represents a plan of a portion of the under-framing only of a set of carriages or waggons, constructed and coupled together according to this invention.

The under-framings, A, of the carriages or waggons of a train are coupled together from centre to centre, B, B, of the framing as shown, in lieu of being coupled at the extremities of the frames as heretofore; and it is also proposed to substitute for the ordinary buffers, in conjunction with this mode of coupling, a curved abutting surface, C, on the end of each framing, the curve being struck from the coupling centres, B. The coupling or traction bars, D, D, may be either rigid, as shown, or combined with the usual or other draw springs, and may consist of chains for a portion of their length; and the curved abutting heads, C, C, may also be either rigidly fixed to the framing, as shown, or be combined with metal or india-rubber springs for the sake of elasticity. The curved ends may be lined with india-rubber, and should be covered with sheet-iron plating. The coupling bars, D, D, which are connected at each end to the centres, B, B, of the several frames of the carriages or waggons, are divided in the middle as shown, each half being connected to the other by any convenient arrangement of screw coupling as at F, for the facility of tightening up the two waggons. The coupling bars, D, D, may be either above the frames, as in the engraving, or below. It is obvious that this coupling bar will always form the chord of the arc or curve traversed by the waggons or carriages so coupled together; and as the tractive force is applied through the said chord the line of draught will always, when passing over curves, be situate between the centre line of the curved track and the inner rail of the curve, in lieu of outside the centre line as in the ordinary mode of coupling.



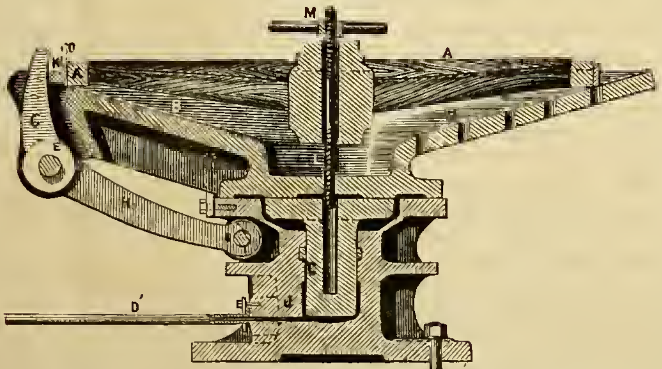
By the arrangements hereinbefore described the centres of the axles, I, I, of the several waggons or carriages, A, are always kept in the same relative position to or distance from each other, and consequently motion may be communicated from one to the other by means of driving straps, bands, or chains, in conjunction with pulleys fast on the axles, which will be readily understood without the necessity of engravings. If desired, auxiliary buffers may be adapted centrally to the ends of the frames, and caused to project beyond the curved heads when uncoupled, in order to prevent shocks when the waggons or carriages are brought together for coupling up, or when otherwise subjected to shocks.

WHEELS.

Auguste Colas, *of Paris.—Patent dated* 16*th March*, 1868.

This invention relates to an improved mode of, and apparatus for, applying the tyres to ordinary wooden wheels for carts, carriages, and other like vehicles, whereby the disadvantages arising from charring or partially destroying the wooden felloes, and from the heating and subsequent sudden cooling of the metal composing the tyre in order that it may shrink on to the wheel, whereby its strength is impaired, as at present adopted, are entirely obviated.

According to this invention, in lieu of first expanding the tyre and then contracting it after it has been adjusted in its place on the wheel, it is proposed to leave the molecules of the iron in the tyre in a state of perfect rest, and to produce a contraction and expansion in the wooden portions of the wheel, thus, in effect, reversing the usual mode of proceeding. One arrangement of apparatus by which this invention may be practically carried out, consists of a circular platform, the upper surface of which is dished, or inclined downwards towards the centre. To this platform are jointed a number of levers, the upper and shorter ends of which serve to compress radially the wheel, which is laid horizontally upon the platform, whilst the longer ends bear against the central fixed portion, or main standard, or support, of the apparatus. Within this standard there is formed a hydraulic cylinder, and into this works a ram, which supports the platform above referred to. On forcing liquid into the hydraulic cylinder the platform will be elevated, and the levers will compress the parts of the wheel together. In this compressed state the wheel is screwed firmly down at its centre on to the platform, and is maintained in its compressed condition by the inclination of the platform, even after the compressing levers are released. The tyre is now slipped on, and the wheel is then allowed to expand again, thereby effectually securing the tyre in its place without the application of heat.



The engraving represents a vertical section of the improved machine. The wheel, A, is placed upon the platform, B, the internal surface of which is conical or dished. The platform is capable of being elevated by the action of the ram, C, worked by a hydraulic pump, D, which forces liquid underneath the ram through the pipe, D′. When rising, the platform, B, carries with it the axes, E, upon which are mounted the compressing levers, G, and long arms, H, which latter may work freely upon the axes, E, in the main standard or central support, J. By reason of this rising motion the axes, E, are lifted, and the levers, G, press against the blocks, K, in order to compress them against the periphery of the wheel, A. The compression of the wheel, A, causing a diminution in the diameter thereof, it is free to descend lower upon the dished or hollow conical platform, B, under the action of the fly-wheel or cross arms at M, working on the upper portion of the vertical screw spindle, L, which is secured firmly to the centre of the platform. By these means a certain amount of compression from the periphery towards the centre of the wheel, A, is obtained, and will be maintained even after the pressure of the levers, G, has been removed, since, on the one hand, the nut at M prevents the wheel from rising, and on the other, the inclined or sloping surface of the platform, B, equally prevents the circumference of the wheel from rising up and expanding. At this stage, and without necessarily releasing the levers, G, from the periphery of the wheel, the band or tyre, O, may be brought into the position shown in dotted lines; then, after having removed the pressure and allowed the ram and platform to descend, the blocks, K, are removed or displaced, so as to bring them into the spaces between the levers, G, in order to permit of the complete adjustment of the tyre, O, into the position indicated by dotted lines. So soon as the tyre has been placed on the wheel the operation is finished, the nut, M, is slackened, and the wheel by its inherent elasticity expands against the interior of the tyre, O, and holds it firmly in its place.

CAST STEEL AND MALLEABLE IRON.

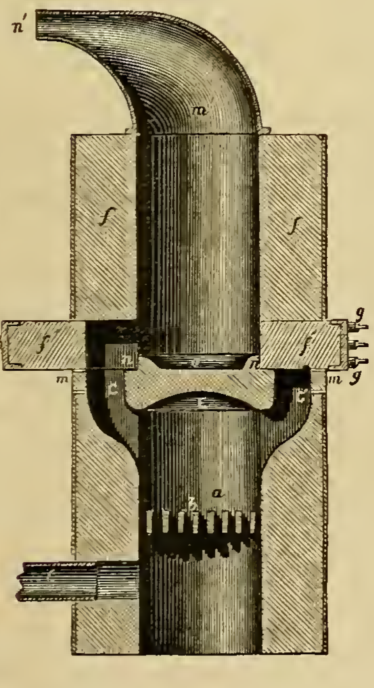
F. Ellershausen, *Ottawa, Canada.—Patent dated 3rd April*, 1868.

This invention relates to a peculiar process for manufacturing cast steel and malleable iron direct from cast iron, and to certain peculiar constructions and arrangements of apparatus to be employed for that purpose. The peculiar process whereby cast iron is converted into cast steel or malleable iron, consists essentially in the use of oxides of iron in a form possessing a considerable extent of surface, such, for example, as spongy iron as it comes from the puddling furnace, or sheet iron or iron curlings, somewhat similar to the beech shavings used in vinegar generators. This curled sheet iron is placed in a vessel or receptacle called the convertor, which is capable of being brought into communication with a furnace, in order to bring the sheet-iron curlings to a white heat, which temperature is maintained during a sufficient length of time to insure complete oxidation of the metal. When this is accomplished, the communication with the furnace is shut off, and a quantity of molten cast iron is poured into the convertor, so as to unite with the oxide of iron. The great object in this process is to expose as large a surface as possible of oxide of iron to the fluid cast iron, so as to effect a rapid and simultaneous combustion throughout the entire mass, which increases the temperature to such a degree as to cause the conversion to be completed whilst the metal is in a fluid state. Before the cast iron is introduced into the convertor, decarbonizing and purifying, or steel-improving agents, such, for example, as oxide of manganese, may be strewn or deposited in the interstices of the sheet-iron curlings, or its substitutes, in order to facilitate the combustion and purification. The subsidence of the combustion will indicate that the conversion is completed, when the metal may be run off and the process repeated.

According to one arrangement of apparatus for carrying out or applying the peculiar process hereinbefore described, a converting vessel or chamber is constructed upon the upper portion of a furnace, which may be of any convenient size and form, and be provided with blast-pipe and fire-bars. The convertor is divided from the furnace internally, by an arched division which forms the bottom of the convertor and the roof of the furnace. A series of flues or passages are made round the said division, communicating with the furnace, in order to allow of the curled iron, or its substitute, placed in the convertor, being thoroughly heated. Each flue or passage is capable of being closed, at pleasure, by a sliding stop of fireclay or other suitable material, capped outside with metal, which stops are held in position, when closed, by means of holdfast screws, in order that they may not be forced out by the pressure of the molten metal in the convertor. Loose blocks or doors are provided for affording ready access to the interior of the flues or passages, and to the seats of the sliding stops, for repairs. The bottom of the convertor is hollowed or dished slightly, in order that in the event of any of the metal in the act of oxidizing becoming fluid, it may receive the same. A movable hood or cap is fitted on to the top of the convertor, of the same form and diameter at the base as the interior of the convertor, but tapering towards the mouth, which is curved to one side, and is in connection with a chimney shaft.

According to another modification of apparatus, a removable cast-iron flue serves to convey the flame and heat from the furnace to the convertor, which convertor is supported on pillars or columns on the furnace roof; the said flue being placed over the aperture of the furnace when required for use, and removed again when not wanted. A flap-door or false bottom is hinged to the bottom of the convertor, and when this door is open the interior of the convertor is in immediate contact with the flame from the furnace, which is carried up through the circular removable flue. A lateral discharge aperture for the molten metal is formed at, or near, the bottom of the convertor, and upon the top of the convertor there is fitted, by hinges or otherwise, a cap or hood of the form above described.

Fig. 1.



In converting cast iron into cast steel by the aid of either of these apparatus, curled sheet iron is placed in the convertor; after which the hood is applied and connected with the chimney, and the sliding stops or removable flue are adjusted. Fire is then raised in the furnace beneath until the sheet-iron curlings, or substitutes therefor, in the convertor are brought to a white heat, and so maintained till complete oxidation has taken place. The sliding stops are then closed, or the circular flue is removed, the door or flap (if used) is closed against the bottom of the convertor, and the top or hood is turned over. A sufficient quantity of molten cast iron is then poured into the convertor to unite with the oxide of iron, causing rapid combustion throughout the mass and effecting conversion.

Fig. 1 of the engravings is a vertical section of one arrangement of the improved furnace and convertor, and fig. 2 is a plan of the convertor with the cap or hood removed. *a* is the furnace, *b* the fire-grate, *e* a fan-blast pipe underneath the fire-bars. The convertor, *f*, is placed directly over the furnace, *a*, as shown in fig. 2, separated from it, however, by the arched roof, E. In order to heat the curled sheet-iron rolls which are placed in the interior of the convertor, four or more flues, c c′, are arranged for the purpose of allowing the flame and heat to proceed from the furnace into the convertor *f*. *f′ f′* are stoppers made of refractory material, and so arranged as to slide in and out, opening and closing the flues in doing so, as shown in fig. 2, where the flue, c, is shown open, and the flue, c′, closed. These stoppers, *f′*, are provided with holdfast screws, *g g*, to prevent any movement of the stoppers when the pressure of the liquid metal in the convertor is acting against them on the inside. In order to enable the operator to gain access to the flues, and also to repair any damage, with cement, in the corners, *n*, loose blocks, *m*, are so arranged as to afford access to that part; *a′ b′* are metal caps attached to the outer ends of the stoppers, *f′ f′*. The bottom of the convertor is curved or dished in the manner shown at *o*, so that in the event of any of the metal in the act of oxidizing becoming fluid it will be retained; *l* is the discharging spout for running off the molten converted metal; *m′* is a hood or cap piece, more fully referred to below, having an open contracted mouth at *n′*.

Fig. 2.

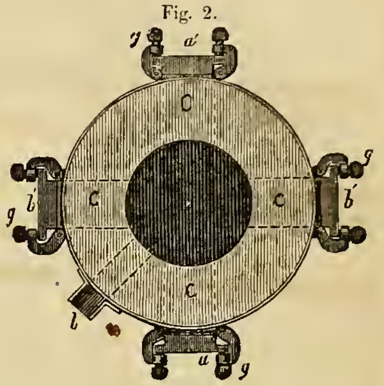
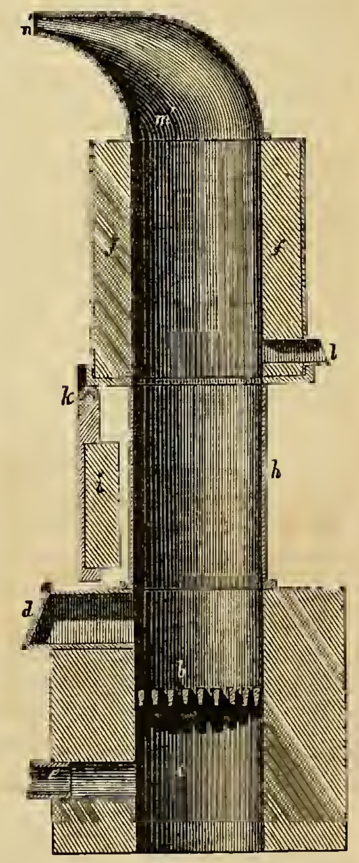


Fig. 3 is a vertical section of another modification of furnace and convertor. *a* is the furnace, of any convenient size or form, provided with fire-bars, *b b*, ash-pit, *c*, feeding door, *d*, for the admission of fuel, and blast-pipe, *e*, of the usual form. On the top of this furnace is placed the convertor, *f*, constructed of brick, with an external boiler-plate casing to strengthen the same, as in the first modification; it may be supported on pillars, *g′ g′*, resting on the top of the furnace. *h* is a removable flue, for the purpose of conveying the flame or heat from the furnace to the convertor. This flue is circular in form, of cast iron, and placed over the aperture of the furnace when it is required to pass the flame or heat through the convertor. This flue is removed from under the convertor when it is required to close the flap-door or false bottom, *i*, attached to the lower side of the convertor by the hinge, *k*; this door is also lined on the inside with fire-brick. When this door is open, the whole interior area of the convertor is in immediate contact with the flame from the furnace carried through the flue, *h*, which is then in place for that purpose. *l* is an aperture for the discharge of the molten metal from the convertor, when the same is ready for withdrawal; *m′* is the hood or cap-piece of metal, of the peculiar form shown in the drawings, circular at the base, and of the same internal diameter as that of the convertor; it is attached to the top of the convertor by a hinge or other suitable fastening, so arranged as to permit of its being elevated or turned back when required. This cap-piece terminates in a reduced diameter at *n′*, for the purpose of connection with a chimney shaft to carry off the products of combustion.

Fig. 3.



On the principle that carbon cannot exist at a white heat in the presence of oxygen without combustion ensuing, and also that the combustion will proceed with a rapidity dependent on the extent of surface exposed to the united action of the carbon and oxygen with an increase of temperature, the invention or discovery has been made, that by the use of certain mechanical appliances in conjunction with the foregoing, cast iron may be readily converted into cast steel or into malleable iron, and which may be accomplished in the following manner, with greater economy both in time and expense, and at the same time yielding a superior description of steel or malleable iron.

These results are brought about in the following manner:—Sheet iron is curled in a similar manner to the beech shavings used in vinegar generators, and is placed in the interior of the convertor, *f*; this vessel is open at the top, but is provided with means for the upward passage of the flame from the furnace, *a*, through the interior of the convertor; the cover, *m′*, is then put in place and connected with the chimney, the flues or passages, C C, or the lower door, *i*, are opened, and the flue, *h*, in the latter arrangement put in place. Fire is then introduced into the furnace, *a*, and the temperature raised to such a degree as to bring the sheet-iron curlings in the convertor to a white heat, and continued for a sufficient length of time to insure the complete oxidation of the same. When this is accomplished the flue, *h* (if employed), is removed, and the door, *i*, closed, and the top cover, *m′*, is turned over, or the stops, *f′ f′*, in the first arrangement, are pushed in, so as to close the passages, C C. A sufficient quantity of molten cast iron is then poured into the top of the convertor, to unite with the oxide of iron as may be required. It will be evident from the manner in which the sheet-iron curlings, afterwards converted into an oxide of iron, were originally placed in the convertor, that a large surface of oxide of iron is exposed, within a comparatively small space, to contact with the incoming molten cast iron, uniting the particles of each in close conjunction, and causing a rapid combustion throughout the entire mass, which increases the temperature to such a degree as to effect the conversion while the metal is in a fluid state. In place of the sheet-iron curlings other oxides may be used, if they possess the desired extent of surface; for instance, spongy iron as it comes from the puddling furnace.

In either of the above cases, before the cast iron is introduced into the convertor, decarbonizing and purifying, or steel-improving agents, such, for instance, as oxide of manganese, may be strewn or deposited in the interstices of the sheet-iron curlings, or its substitutes, in order to facilitate the combustion and purification. When the conversion is completed, which can be easily determined by the subsidence of the combustion, the metal is drawn off through the tap or discharge spout, *l*, and the process is repeated. The quantity of metal to be operated on during each conversion may range from one-half of a ton to ten tons.

TREATING PARAFFINE, FATTY, AND RESINOUS MATTERS.

LEO DE LA PEYROUSE, Somerset Street, Middlesex.—*Patent dated 27th September*, 1867.

RAW or crude paraffine of commerce is, as is well known, a mixture of paraffine, tar, carbonaceous matters, heavy mineral oils, and colouring matters, and the purification or refining of such paraffine, as well as its decoloration, consists in the separation of the before-mentioned substances.

In order to effect the separation of the tarry and carbonaceous matters, it is proposed to employ such chemical agents as possess the property of removing the before-mentioned impurities, and of concreting a portion of the heavy oils contained in the paraffine; also such chemical agents as will effect the precipitation of the tarry matters contained in the crude paraffine, as well as the precipitation of the colouring matters, so as to yield paraffine entirely free from tarry matters, and both limpid and transparent, and of a white, or gray, or pale yellow colour. A method of separating the tarry matters from the crude paraffine, by maintaining the same in a state of fusion for a given time at a temperature of about 60° Centigrade, is also adopted. The tarry matters and other impurities being denser than the paraffine, sink, and the paraffine is withdrawn in a purified condition. Before proceeding to effect, by means of pressure, the separation of a portion of the mineral oils contained in impure paraffine, such chemical agents as possess the property of combining with a portion of the heavy mineral oil, clarifying the liquid paraffine, and abstracting from it the greater portion of the colouring matters, are caused to act on the dissolved paraffine. Natural and artificial cold are also employed, so as to obtain and retain the paraffine in a solid form, such as cake, or otherwise, at a temperature of from about 6° to 10° Centigrade below zero, for the purpose of separating the mineral oils therefrom. Saponifiable liquid fatty bodies are also used, as well as such liquid bodies which have a boiling point of about 100° Centigrade, such as chloroform, naphtha, hydruret of amylene, for the purpose of effecting the separation of mineral oils by solution from impure paraffine.

In order to separate the tarry and carbonaceous matters contained in crude paraffine, it is first melted or fused by heating it to a temperature of from 120° to 130° Centigrade; the water and the earthy matters which are contained in the crude paraffine are thereby separated, and the paraffine is then agitated either mechanically or otherwise, and to it is added, during such agitation, such quantities of sulphuric acid, containing in solution either nitrous acid or sulphurous acid, or mixtures of the same, as may be requisite for effecting the separation of the colouring matter, and to concrete the tarry and oily compounds contained therein; these concreted products are allowed to settle, and the clear paraffine is decanted. Or a solution of chloride of zinc is employed, and by preference, such a solution of the same in water as shall have a boiling point of about 120° Centigrade. This solution is raised to about its boiling point, and the crude paraffine is placed therein; and after submitting it to the action of such a solution of chloride of zinc for such time as shall be necessary to destroy the colouring and other matters, and to concrete the tarry products, the impurities are allowed to subside, and the paraffine then removed. By these processes the concretion of the tarry matters and of a portion of the heavy mineral oils will be effected, and the paraffine will become purified.

Similar results may be obtained by employing nitrous acid, azoto amidon, obtained by mixing nitric acid and starch, or obtained by other means; sulphuretted hydrogen and its compounds may also advantageously be employed for like purposes.

As a bleaching agent sulphurous acid is employed, which is introduced either into the melted paraffine as a gas, or is generated in the vessel containing the paraffine.

In order to effect the precipitation of the tarry and carbonaceous matters, alkaline or earthy sulphurets, hydro-sulphurets, hypo-sulphites, or sulphites, are employed, and after effecting the separation of such tarry and carbonaceous matters, by any of the processes hereinbefore-mentioned, the paraffine is allowed to deposit any insoluble impurities it may contain, during which time it is maintained in a liquid state, and after subsidence it is drawn off through cocks provided for that purpose; but the discharge cock placed at or about the bottom of the vessel is, by preference, not opened until the purified paraffine has been drawn off.

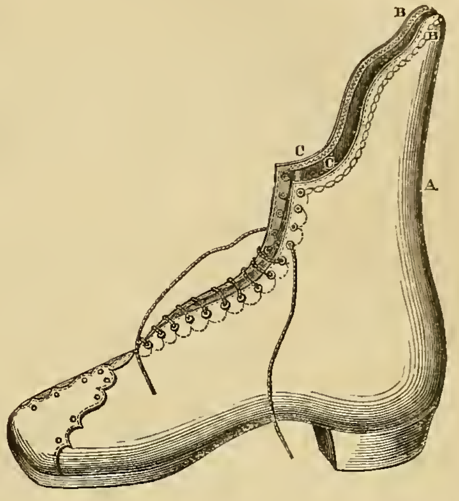
It is preferred to wash the paraffine after having been thus treated with hot or tepid water before commencing the decoloring process. The decolorization is effected by means of oxygen, which may be produced either in the melted paraffine, or be introduced therein in a gaseous form at or about the bottom of the vessel containing the paraffine. And as decolorizing agents, such other substances as sulphurous acid are employed, which have been found to give good results. Alumina, either in a hydrated condition or in the form of refractory clay, pipe-clay, kaolin clay, or otherwise, may also be employed. The salts of alumina, such as alum, may be advantageously employed for the decoloration and clarification of paraffine, and for the precipitation of the colouring matters contained therein. The pulverulent matters hereinbefore described may be employed either in solution of water, or they may be treated with the paraffine, the same being kept stirred or agitated; a jet of steam may advantageously be introduced into the paraffine during such operation. After this process it is subjected to a process of filtration, and to it is added from 10 to 20 per cent. of a saponifiable oil, or some volatile spirits extracted from solid or liquid bituminous matters or resin, obtained from the distillation of seaweeds rich in paraffine and tar, chloroform, ether, hydruret of amylene. The liquid paraffine is then run into moulds, where it is allowed to crystallize slowly; the moulds are cooled to a low temperature so as to effect perfect solidification; this solidification is obtained at a temperature varying from 5° to 8° Centigrade below zero; it is then pressed at a low temperature, as before described. The heavy mineral oils which discolour the crude paraffine are thus separated, and on the examination of the cakes it will be seen whether it be necessary to repeat the operation, or whether the bleaching and purification can be proceeded with at once, either by simply filtering it when in a heated state through animal charcoal in the ordinary way, or otherwise.

What has been previously stated respecting the treatment of the hydrocarbons called paraffine, is equally applicable to the treatment of the animal and vegetable fats and oils, such as grease, lard, suet, tallow, palm oil, cocoa-nut oil, vegetable suet, Japan wax, and resinous matters, and more particularly to the treatment of suets and tallow, the purification of which may be advantageously effected as follows:—If suet is required to be treated it should be melted in a wooden vat lined with lead, and containing a quantity of water equal to at least 25 per cent. of the suet to be operated upon. Placed in this vat is a leaden worm intended to admit of the circulation of the steam, or an open steam-pipe may be placed therein in order to raise the temperature of the contents of the vat, so as to expedite the melting of the suet. With a view to disintegrate the cellular portion of the suet for the purpose of extracting the whole, or nearly the whole, of the tallow therein contained, about two and a half per cent. by weight of vitriol or commercial sulphuric acid is added to the contents of the vat, previously diluted with from three to four parts of water. In melting the suet with the acid, and when the melting is in part effected, the development of the nascent oxygen takes place, which produces a whiteness and solidity such as no other method of treatment hitherto adopted has effected. In order to obtain this nascent oxygen any matter suitable for the development of oxygen may be used; but mineral peroxides are preferred, to which are added a sufficient quantity of vitriol or commercial sulphuric acid at 45° B., such as the peroxides of manganese or permanganates, which should be employed in the proportion of from 1 to 5 per cent. of the quantity of suet to be treated, according to the degree of whiteness and firmness required. By continuing the operation for about five hours the glycerine will be set free, and may be separated by pressure or otherwise. The chlorides and perchlorides of zinc and of tin, which are employed by preference at from 40° to 45° Baumé, give similar results, producing especially great firmness, which may be carried to the utmost limits without the fatty body losing any of its illuminating qualities.

The treatment with nascent sulphurous acid above described, is also advantageous. What has been stated in reference to the treatment of suet equally applies to the treatment of tallow. The mixture and union of certain hydrocarbons with suet or tallow imparts to them new and hitherto unknown properties; thus, by adding to melted suet from 2 to 5 per cent. of bodies boiling between 75° and 100° Centigrade, such as volatile spirits extracted from solid or liquid bituminous matters from resin, from the distillation of seaweeds, and other sources, and by mixing them well together, there will be obtained, either with or without pressure, a new product both dry and brilliant, and particularly suitable for the purposes of illumination, either with a plaited or woven wick, and capable of being economically substituted for composite and other candles. The suet or tallow, after having been treated as before mentioned, is then submitted to pressure or otherwise, and is mixed with either palmitic acid, paraffine, Japan wax, refined Canabar wax, or mixtures of the same, in the proportion of about 15 to 20 per cent. of the weight of tallow or suet employed; the resulting material will be found to be well adapted for the manufacture of candles, and it will be evident that the proportions in which the before-mentioned ingredients are to be employed will be dependent on the hardness and quality of the candle required. By treating suet and the fatty bodies with those compounds which have a boiling point between 75° and 100° Centigrade, increased whiteness and brilliancy are produced. The decomposition, by means of acids or otherwise, of the suets, may be effected either before or after they have been submitted to the before-mentioned process.

REGISTERED DESIGN.

Leglet Boot.—Mr. Richard Carleton, of Dublin, has registered a new design of leglet boot. The purpose of utility to which the shape or configuration of the new part of this design has reference is to afford a convenient substitute for ladies' leglets, whereby the trouble of lacing the entire leglet of the long-legged boots at present in use is obviated; whilst, at the same time, the requisite protection is afforded, and the appearance of the ordinary front-laced boot, when seen from the front, is retained. The engraving represents a perspective view of the Carleton leglet boot, which consists of an ordinary front-laced boot, the back of which is continued upwards, as shown at A, B, C, C, so as to form a protection where it is most required, namely, at the back of the stockings, which are thus preserved from mud, and from the contact or friction of the skirts against them.



PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ON THE RELATION OF FOOD TO WORK DONE BY THE BODY; AND ITS BEARING UPON MEDICAL PRACTICE.

By the Rev. S. Haughton.

(*Concluded from page* 221.)

Before investigating the truth or falsehood of Liebig's theory, it is worth while to state the most recent results obtained as to the muscular work per day of which man is capable.

From numerous observations, of which some were made by myself, on the daily labour of hodmen, paviours, navvies, and pedlars, I have obtained the following mean:—

Daily labour of man = 353·75 foot tons. = 109,549 kil. met.

This quantity of work is the exact equivalent of the work done by a man of 150 lbs. weight in climbing through one mile of vertical height, and is, as I have already shown, less than *one-eighth* part of the work expended in producing and maintaining animal heat.

Even if we add to the external muscular work that of circulation and respiration, which may be estimated at 133 foot tons, the whole work done by the muscles, voluntary and involuntary, of a hard-worked labourer will amount to less than *one-sixth* of the work expended in maintaining the temperature of his body at 100° F.

I was led to believe, from my investigations as to the quantity of urea excreted in various diseases, that a certain minimum quantity, equivalent to 2 grs. per pound av. of body weight, was excreted quite independently of muscular exertion, and I proved that death was preceded in many chronic diseases by a fall in the urea excreted to 2 grs. per pound. These investigations were made chiefly on patients dying of advanced kidney disease, in which the excretion of albumen had nearly or altogether ceased, and on patients dying of phthisis.

Pettenkofer and Voit found that the excretion of urea in a dog reduced to 29 kilos. by ten days' fast was reduced to 8·6 grms. And, since

29 kilos. = 63·8 lbs.
8·6 grms. = 132·7 grs.
Excretion of urea = 2·08 grs. per lb. of body weight.

Ranke obtained a precisely similar result from observations made upon himself after long fasting, continued for several days.

If these views be well founded, it is plain that part only of the urea excreted can be regarded as due to muscular exertion, for 2 grs. per lb. (or 300 grs. for a man weighing 150 lbs.) must be set aside as a constant due to vital work, independent of muscular work altogether. Hence it would follow, supposing the muscular exertion to be measured by the increased excretion of urea produced by it, that the urea will not increase as fast as the muscular exertion, but it ought to increase regularly, although at a slower rate. With a view to settle this important question, I devised the following observations upon myself in the month of July, 1866, which prove conclusively that an increase of muscular exertion, amounting to fourfold, is not accompanied by any corresponding increase in the excretion of nitrogen, in the form of urea.

I had previously ascertained by repeated experiments, extending from 1860 to 1865, that my excretion of urea, under ordinary conditions as to exercise (which did not exceed 5 miles per day), ranged from

465·09 grs. per day, to
537·47 grs. per day.

501·28 mean.

This quantity of urea I regarded as my natural physiological average, and it was so well established, that I thought I should obtain an important result by comparing it with the average found from several days of unusual muscular exertion. I accordingly walked for five consecutive days in the hilly districts of Wicklow, noting carefully the horizontal distance traversed each day, and the vertical height traversed up and down. The vertical heights were reduced to horizontal distances, on the assumptions (which are well founded) that 20 is the proper coefficient for converting one into the other, and on the assumption that the work of descent is half the work of ascent.

During the five days of observation the work done, expressed in horizontal miles of walking, was as follows (here follow the particulars).

From the preceding statement it follows that the average work done each day was 20·74 miles of horizontal walking—the result of which upon the urea excreted was to be compared with the result already mentioned, as a physiological constant determined under circumstances in which the daily muscular work never exceeded 5 miles of horizontal walking.

In order to determine the urea, I collected each day all the urine passed, and kept one-fifth part of it; and at the close of the fifth day examined the mixture formed from the five days' urine.

It was found to contain 501·16 grs. of urea per day—a result identical with the physiological quantity previously found by me under totally different conditions, viz., 501·28 grains.

I was much surprised at this result, for I had previously believed in the theory laid down by Liebig, which attributed the excretion of urea to the disintegration of muscular tissue.

It might be objected to the preceding reasoning that there can be no doubt as to the capability of the combustion of proteinic compounds represented by 501·28 grs. of urea excreted to produce mechanical force sufficient to explain the muscular exertion of walking 20 or 21 miles per day; as may be shown in the following manner:—

1. The urea excreted bears to the proteine consumed the proportion of 24 to 79; as appears from their chemical compositions—viz.,

Urea,	$C_2 H_4 N_2 O_2$	60
Proteine,	$C_{36} H_{27} N_4 O_{12}$	395

2. In 100 parts of proteine there are 53·7 parts of carbon and 7 parts of hydrogen; the total heat due to the combustion of 1 grm. of proteine is, therefore,

	Heat Units.
0·537 grm. of Carbon,	4·3389
0·070 grm. of Hydrogen,	2·4123
	6·7512

This number, 6·7512, represents the maximum quantity of heat units * that could be produced by the combustion of 1 grm. of proteine; but the term depending on hydrogen in it should be reduced to five-ninths of its amount, in consequence of the hydrogen already combined with oxygen in the proteine. Hence we find—

Combustion of 1 *grm. of Proteine.*

Carbon,	4·3389 heat units.
Hydrogen,	1·3402 "
	5·6791

3. In 100 parts of urea there are 20 parts of carbon, and 6⅔ parts of hydrogen; the total heat, therefore, due to the combustion of 1 grm. of urea is

0·20 grm. carbon,	1·6160
0·067 grm. hydrogen,	2·3089
	3·9249

The term depending on hydrogen, in this result, should be reduced to one-half, in consequence of the hydrogen already combined with oxygen in the urea. Hence we find—

Combustion of 1 *grm. of Urea.*

Carbon,	1·6160
Hydrogen,	1·1544
	2·7704

4. From the three preceding statements it is easy to see that, for every gramme of proteine consumed, 0·8416 heat units are contained in the urea excreted; so that

The digestion of 1 *grm. of proteine gives out* 4·8375 *heat units.*

It is easy to see that 501·28 grs. of urea excreted correspond to 1650 grs. of proteine in the food, or to 106·92 grms.; and the total work due to the digestion of this quantity of food may be found by multiplying it by the *digestion coefficient* already found, and by 423, which is Joule's coefficient for converting heat-units into kilogrammetres. Hence we have—

Work due to production of 501·28 *grs. of urea.*

$$= 106{\cdot}92 \times 4{\cdot}8375 \times 423$$
$$= 218786 \text{ k. m.}$$
$$= 704 \text{ foot tons.}$$

This amount of theoretical work produced by nitrogenous food, is more than double the work actually done during the walking excursion.

The average work was 20·74 miles horizontal per day, which may be considered as the exact equivalent of lifting my weight (knapsack and clothes included = 150 lbs.) through 1 mile of vertical height. Hence the work actually done by me was

$$\frac{150 \times 4280}{2240} = 354 \text{ foot tons.}$$

I have elsewhere shown that the work done by the heart per day amounts to 122 foot tons, which should be added to the external work, as well as the unknown work due to the muscles used in respiration, probably amounting to one-sixth of the heart's work, or 21 foot tons; adding these quantities, we find—

External work,	354 foot tons.
Circulation and respiration,	133 "
	487 foot tons.

This quantity represents 69 per cent. of the applied work, which was shown to be 704 foot tons.

The amount of muscular work accounted for is 354 foot tons, which is almost exactly half the whole theoretical work supplied by the food that goes to form urea, viz., 704 foot tons; but it has been already shown that 2 grs. of urea per pound of body weight is required to maintain the vital work, including circulation and respiration; this would give from 240 grs. to 260 grs. of urea out of the 501 grs. available for vital work, so that one-half of the available work may be considered as expended on vital work, and the other half as expended on external muscular work. This supposition, however, requires us to believe that the muscles act without loss by friction. This is not admissible, for I have elsewhere endeavoured to show that there is a loss in the force applied by the muscles of various animals, in consequence of the friction of their tendons, amounting—

In man to	35 per cent.
In the mastiff to	41 "
In the kangaroo to	61 "

Hence it may be regarded as certain that the available force represented by 501 grs. of urea is not sufficient to account fully both for vital work and for the external mechanical work expended by me during the experiments just described.

The foregoing observations and calculations were made in the month of July, 1866, but I did not then publish them, as I found afterwards that I had been anticipated by Dr. Fick and Dr. Wislecenus, of Zurich, in a paper published in June in the *Philosophical Magazine*, on the urea excreted during an ascent of the Faulhorn. Professor Frankland, in a paper published in the same journal in September, 1866, corrected some erroneous reasoning that found its way into Fick's and Wislecenus' paper, and further supplied, from direct experiment, the *digestion coefficient* of proteine, which had been obtained by me from calculation. The actual value of this important constant was found by him to be—

Actual value of digestion coefficient of proteine,	4·3155
Calculated value,	4·8375

Liebig and his followers, misled by a preconception of the simplicity of nature, assigned to nitrogenous food the duty of providing the force necessary for the production of muscular work, by supplying the waste of muscular tissue; while they supposed the farinaceous and fatty foods to provide the amount of animal heat required by the body.

The opponents of Liebig have fallen into the opposite error, and deny that nitrogenous food contributes any portion of the force employed in muscular work.

The truth, as is usual, lies between the two extreme hypotheses, and we are now compelled to admit that a given development of force, expressed in animal heat, muscular work, and mental exertion, may be the effect of several, perhaps many, supposable supplies of digested food, farinaceous, saccharine, fatty, and albuminous.

Lavoisier supposed in his earlier investigations that animal heat was developed by the combustion of carbon and hydrogen in the lungs; just as in earlier times it was supposed to be produced spontaneously in the heart, which was imagined to be so hot as even to burn the hand that should imprudently venture to touch it.

In like manner, Liebig and his followers supposed the muscular work to be developed in the substance itself of the muscles that were its instruments.

Both of these doctrines are now justly repudiated by physiologists, and the view, proposed in 1845, by Dr. Mayer, of Heilbronn, and recently developed with much ability by Mr. C. W. Heaton, of Charing Cross Hospital, in the *Philosophical Magazine* for May, 1867, that the blood itself is the seat of all the chemical changes that develop force in the body, has gained favour among physiological chemists, and also met with acceptance among practical clinical observers.

No two classes of animals can well differ more from each other than the cats and ruminants, one of which is intended by nature to eat the other. They differ in all respects as to food, the cats requiring a supply of fresh meat and blood for their health, and the ruminants being exclusively vegetable feeders; yet in both classes we find a great development of muscular power, and of rapid action of muscles, qualities alike necessary to the pursuer and to the pursued. There can be no doubt that muscular work is developed in the cats from the combustion of flesh, and in the ruminants, mainly, if not exclusively, from farinaceous food. It is, however, worthy of remark, that the muscular qualities developed by the two kinds of food differ considerably from each other. The hunted deer will outrun the leopard in a fair and open chase, because the work supplied to its muscles by the vegetable food is capable of being given out continuously for a long period of time; but in a sudden rush at a near distance, the leopard will infallibly overtake the deer, because its flesh food stores up in the blood a reserve of force capable of being given out instantaneously in the form of exceedingly rapid muscular action.

In conformity with this principle, we find among ourselves an instinctive preference given to farinaceous and fatty foods, or to nitrogenous foods, according as our occupations require a steady, long-continued, slow labour, or the exercise of sudden bursts of muscular labour continued for short periods. Thus chamois hunters setting out for several days' chase provide themselves with bacon fat and sugar; the Lancashire labourers use flour and fat, in the form of apple dumplings; while the Red Indian of North America almost transforms himself into a carnivore, by the exclusive use of flesh food; he sleeps as long, and can fast as long as the puma or jaguar, and possesses stored up in his blood a reserve of force which enables him, like a cat, to hold his muscles for hours in a rigid posture, or to spring upon his prey like a leopard leaping from a tree upon the back of an antelope.

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* Heat unit = 1 kilog of water raised 1° C.

If the preceding view of the muscular qualities developed by the two kinds of food be correct, important inferences suggest themselves as to the food that should be employed in relation to several kinds of work. Of these inferences, I shall select two examples:—

1. The nurses of one of our Dublin hospitals were formerly fed chiefly upon flesh food and beer, a diet that seemed well suited to their work in ordinary times, which was occasionally severe, but relieved by frequent intervals of complete rest. Upon the occasion of an epidemic of cholera, when the hospital duties of the nurses became more constant, although on the whole not more laborious, they voluntarily asked for bacon fat and milk, as a change of diet from the flesh meat and beer; this change was effected on two days in each week with the best results as to the health of the nurses, and as to their power of discharging the new kind of labour imposed upon them.

2. I have been informed, on competent authority, that the health of the Cornish miners breaks down ultimately from failure of the action of the heart and its consequences, and not from the affection of the lungs called "miner's phthisis." The labour of the miner is peculiar, and his food appears to me badly suited to meet its requirements. At the close of a hard day's toil the weary miner has to climb by vertical ladders through a height of 100 to 200 fathoms before he can reach his cottage, where he naturally looks for his food and sleep. This climbing of the ladders is performed hastily, almost as a gymnastic feat, and throws a heavy strain (amounting from one-eighth to one-quarter of the whole day's work) upon the muscles of the tired miner, during the half hour or hour that concludes his daily toil. A flesh-fed man (as a Red Indian) would run up the ladders like a cat, using the stores of force already in reserve in his blood; but the Cornish miner, who is fed chiefly upon dough and fat, finds himself greatly distressed by the climbing of the ladders—more so, indeed, than by the slower labour of quarrying in the mine. His heart, over stimulated by the rapid exertion of muscular work, beats more and more quickly in its efforts to oxidate the blood in the lungs, and so supply the force required. Local congestion of the lung itself frequently follows, and lays the foundation for the affection, so graphically, though sadly, described by the miner at forty years of age, who tells you that "his other works are very good, but that he is beginning to leak in the valves."

Were I a Cornish miner, and able to afford the luxury, I should train myself for the "ladder feat" by dining on half a pound of rare beefsteak and a glass of ale, from one to two hours before commencing the ascent.

The excretion of nitrogen by the cats and ruminants is very different, as might be expected from their food. I have ascertained that the urea discharged by a Bengal tiger and a sheep daily, is as follows:—

Bengal tiger, ...	4375 grs. of urea.
Sheep, ...	256 "

It is worthy of remark, and serves to throw light on the meaning of the excretion of nitrogen from the body, that causes but slightly connected with muscular exertion in the ruminants increase amazingly the excretion of urea. Thus I have found the following excretion of urea from a ram during the rutting season:—

Ram (rutting season), ...	1493 grs. of urea.

This amounts to a *sixfold* increase of urea, which cannot possibly be accounted for by the food consumed at the time, but requires us to assume a certain storing up of force, represented by nitrogenous compounds, which has been going on for a considerable period previous to the rutting season. A similar and equally remarkable storing up of phosphates and carbonates takes place, previous to the rutting season, in the ruminants that shed their horns, which in the *Cervus megaceros* often weigh 90 lbs.

These remarkable phenomena remind us of the maxim of the wise Hippocrates, who recommends moderation in the use of the gifts of the golden Venus, as well as in those of Ceres and Bacchus—

πόνοι, σιτια, ποτὰ, ὕπνος, ἀφροδισια, μετρια,

with which may be compared its converse in the Latin proverb—

Sine Cerere et Baccho, friget Venus.

We have been compelled, by the principle of "conservation of areas," to editors so important, to omit the whole of Professor Haughton's striking and important applications of the animal work theory to cases of mortal disease, such as cholera and diabetes, as to which it seems likely in the end to introduce a system of rational treatment. We can, therefore, only hasten to the conclusion of his address:—

Conclusion.

I have, now, Mr. President and gentlemen, to apologize for the length of time during which I have spoken, and to thank you for the patience with which you have listened to me. I am well aware how much I am indebted to your kindness, for I laboured under two serious disadvantages in addressing you: in the first place, I had undertaken a task beyond my strength; and again, my address is made shortly after you had, like myself, being charmed and instructed by the luminous, learned, and eloquent oration of Professor Rollestone. I felt confident, however, that I possessed one advantage that he did not; I was a stranger in Oxford, and believed that my faults in matter and style would be leniently criticised; in this expectation, I am happy to say, I am not disappointed; and again I thank you for your kindness. Two other advantages I share with him, which have contributed to his address as much as to my own—a profound respect and reverence for all honest labourers in search of truth, whether they have preceded us by 20 years or by 2000 years; and an unwavering confidence and faith in the future that lies before the Science of Medicine. We traverse a sea, mapped with imperfect charts, carrying with us a sure guide in our compass and stars; but we cannot afford to neglect a single rock or shoal buoyed for us by the skill and care of those that have preceded us. Let us follow their example, and mark with conscientious care, for our successors, the dangers we ourselves discover and escape.

Assembled, as we are, within the halls of the University of Oxford, the centre and heart of all that is intellectual and religious in the life of England; an University that borrows its accurate logic, as well as its refined ethics, from the lips of Aristotle; that reverences Euclid as the fountain and source of its elegant geometry; and sits at the feet of Homer, Pindar, and Æschylus, to learn its poetry; we need not fear that Hippocrates and Galen will ever want admirers and students; but the Oxford of to-day has taught us, what many did not anticipate, that she is equally ready and skilful, as she has proved herself to be in cultivating literature, to devote her vast intellectual energies to the encouragement and development of the natural sciences, based upon the solid and only permanent foundation of mathematical research. The efforts made within the last few years by Oxford, to encourage within her walls the mathematical and natural sciences, have won for her the respect, and warmed towards her the hearts, of all that search for truth in the study of Nature. Our brothers in Oxford, like the Athenians at Syracuse, have gone on board the fleet, while we watch from the shore, sympathizing in the sea fight: as they win, we shout; when they fail, we weep.

Long may the union of the far distant, but never to be forgotten past, with the living present, that now exists in Oxford continue. No science, no profession, can benefit so much by it as that of Medicine.

The *Lancet*, an indisputably good authority, in its part for 29th August, 1868, p. 284, *et seq.*, says of the address from which the preceding extracts have been taken:—"The address of Professor Haughton, at Oxford, on the relations of food and force in the animal economy, marks an era in physiology. We do not mean to say that the Irish professor is the sole competent and final authority on this great question; but he stands in a peculiar relation to it. He is, at any rate, a physiologist of the first rank, and his original researches have conducted him to certain conclusions which come at a very critical time. It is not too much to say that his adhesion, on independent grounds, to what may be called the new physiology of food, is pretty well equivalent, under the circumstances, to a settlement of the chief matters in dispute." In reference to Professor Haughton's views as to the erroneous notions which he affirms are held by those who affirm that the tendency of nature and the meaning of the symptoms in such diseases as typhus and cholera, is that she will *cure* if *she can*, and does not ever desire to kill if natural laws make that avoidable, the *Lancet* continues:—"There was a hearty ring in Professor Haughton's denunciation of that metaphysical figment—'mother Nature,' whom we are to assist with filial reverence, forsooth, in carrying out her pathological designs—which struck home to the common sense of the audience; and when he derisively declared his doubts whether the venerable female in question might not, after all, be only a *stepmother*, with very bad principles and temper, the storm of laughter and cheers that arose had a really prophetic significance, for it meant that the reign of metaphysics in medicine is pretty well over. Altogether, the address was highly successful. The occasion was a great one, the subject was of immense importance, and we feel sure that we speak the general mind when we say that Professor Haughton well performed his allotted task." We are neither physiologists nor pathologists, and desire to speak with the humility of ignorance on such a subject as is here before us; but we have somewhat studied the *Cosmos* as a whole, and endeavoured to interpret from it something of the intents of its great Author, as these may be spelled out by finite intelligences from the facts and observed laws which we call in aggregate, "nature." As a result, we must not shrink from saying that we entertain the utmost distrust in the view that nature ever *intends* to kill—ever plays the part of a bad stepmother. Is not all disease traceable (though not all yet traced) to *ignorance*, to action in conflict with nature's laws? If a man will dwell in a swamp, or will drink foul water, he may get typhus or cholera; was nature's intent, *i.e.*, wish, to kill him? rather was it not, that he is made by her a possible sacrifice, for the good of his fellow men? He and his disease and death are her signals to drain the morass; to drink pure and from the fountain of naturally filtered water she intended for his comfort and his sustenance. Nature desires that all her children should live out in happiness their appointed span of life, and die without pain. Ignorance cuts it short, and fills its span with many sorrows. The doctrine enunciated and so applauded by Oxford, if we have not misapprehended it, seems to us to go back at one bound to the ancient barbarism, "Cursed is the ground," "thorns and thistles shall it bring forth for man's sake," &c.: one sort of angry God, another sort of pleased one; neither him who is "the same yesterday, to-day, and for ever."—Ed.

MONTHLY NOTES.

The Moncrieff Gun-Carriage.—The experiments conducted, 20th ult., at Shoeburyness, in presence of the Ordnance Select Committee, the commandant and officers of the garrison, and a number of military men from Woolwich, Chatham, and Sheerness, for the purpose of testing the Moncrieff gun-carriage, may be considered very satisfactory. The firing commenced later in the day than was expected, owing to other experiments. The gun mounted on the carriage was the ordinary 7-inch, land service, Woolwich gun. Two shots were fired with service charges of 14 lbs. powder and 115 lbs. shot; and afterwards the firing was continued with full battery charges—viz., 22 lbs. powder and 115 lbs. shot. After a few rounds one of the break wheels of the carriage broke, but the firing was continued with still greater success, the carriage being worked with the ordinary tackling by men who previously knew nothing of the working of the apparatus. Captain Moncrieff's design in constructing this carriage is to raise the gun so that it may be fired over a parapet, and to utilize the recoil for bringing back the piece to the position in which it is to be loaded; all the while keeping the gun under cover, except at the moment of firing, and the men who work the gun always protected from an enemy. In this he appears to have been very successful.—*Times.*

Metallic Band Fastener.—Mr. Arthur Barbarin, of New Orleans, has patented certain improvements which relate to a peculiar fastener for securing the metallic bands on bales of cotton or other goods, whereby facility is afforded for readily securing and releasing such bands when required, whilst the fastener itself may be used several times without being injured. It consists of a flat C-shaped piece of metal, provided with an inclined projection or stop at one or both ends, and having in some cases a slot made in the lower part of the fastener, conforming to the inner curve of such fastener. The upper and lower portions of the fastener, and the corresponding portion of the slot when used, may be made straight and parallel or nearly parallel with each other, so as to afford a better hold for the ends of the metallic band, which are to be formed into a loop, secured by being slipped over the ends or into the slot of the fastener, such loops being secured or not by a rivet. When using a slotted fastener it may remain permanently attached to one end of the band; and when it is required to release or remove the bands it is simply requisite to turn the fastener round until its upper limb withdraws itself from the loop in the band. This turning of the fastener is accomplished by the aid of a suitable hooked instrument, which is inserted into one or other of a series of holes made for that purpose in the upper portion of the fastener. In fig. 1 of the engravings the fastener consists of a C-shaped metallic plate, A. When it is desired to open the bale, a hook or other suitable instrument is inserted in one of the holes, *d*, of the fastener when in position on the bale, as shown at M, fig. 2. By pulling the hook when thus engaged with the fastener in a downward direction, the fastener, on account of its curved form, is caused to revolve in the loop, *f*. The upper end of the fastener is thus drawn away from the bent end, *g*, of the band, the latter slipping easily over the inclined face, *a*, of the shoulder, *b*, until it becomes entirely disengaged therefrom, as shown at N. It will be seen that, by the employment of a fastener thus constructed, a metal band can be secured on, or released from, the bale with the greatest ease, and that the fastener itself may be used many times without being materially injured or rendered unfit for use. For some reasons it is preferred that the fastener be constructed with a slot, *c* (fig. 1), for under this arrangement the end of the band is less liable, perhaps, to become detached from the fastener; but in most cases it may be used with equally good results without the slot, or the two forms of fastening may be combined, the end, C, having both a projecting shoulder and the slot.

Fig. 1.

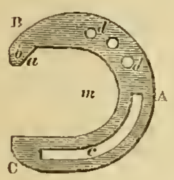
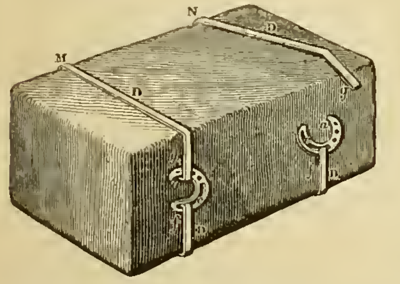


Fig. 2.

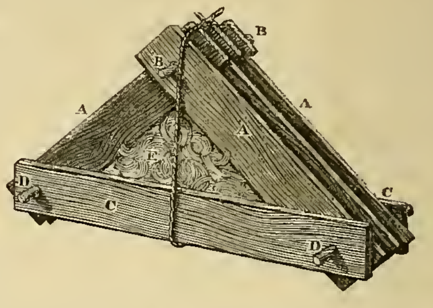


The Submarine Telegraph Company.—Four of the Submarine Company's cables between England and the Continent have been injured this year through storms, but by the energy of the engineer all the injured wires were in working order within sixteen or seventeen days. The delay to the public, however, through accidents has been very slight, for the Dieppe cable conveyed the messages, so that the traffic went on with very little interruption. The shareholders of the Submarine Company have approved the terms for the transfer of their undertaking to the government.

"The Radcliffe Process."—Mr. Jones, of Middlesboro', described the so-called Radcliffe process of making finished iron in a paper read before the mechanical section of the British Association. Five or more puddled balls are put together into a large bloom, under a very heavy steam hammer, shingled down into a bloom, passed for a short time into a heating furnace, and rolled off into finished iron not more than half an hour after leaving the puddling furnace.

The Foreign Coal and Iron Trades.—The iron trade of the south of France has secured a contract for 11,000 tons of rails for the Alfoeld Railway, an Austro-Hungarian enterprise. The total production of the Sarrebruck (Prussia) coal basin in 1867 was 3,171,125 tons, showing an increase of 166,434 tons, as compared with 1866. It is understood that eighty new puddling furnaces are about to be erected at the vast Creusot works, and that the production of Bessemer steel is to be commenced at Creusot on an extensive scale. There is every inducement for the adoption of this course, since the Paris, Lyons, and Mediterranean Railway Company is about to give out a very extensive order for steel rails—as much as 43,000 tons, it is said.

Fire-lighters.—Mr. J. T. White, of King Edward Street, London, has patented certain improvements which relate to a peculiar mode of combining or arranging firewood, with a view to its more rapid and perfect combustion, and consist essentially in so combining or arranging any convenient number of separate pieces of firewood, as that the whole shall form a species of hollow cone, wedge, or pyramid, to be used with the apex upwards. In constructing the improved fire-lighters any convenient number of pieces of firewood, A A, sufficient to light an ordinary fire, are connected together as shown in the engravings, such pieces being of a length of, say, 6 inches by $1\frac{1}{4}$ inch by breadth, and $\frac{1}{4}$ inch in thickness; these dimensions may, however, be varied if desired. This connecting together of the pieces, A, is effected by having a hole drilled through each piece, and passing a wooden pin or holder, B, through the series. A piece of thin cane or willow will answer well as the pin or holder. The several pieces, A, are then opened out in equal numbers, or nearly so, on each side of the pin, B, to form the two inclined sides of the pyramid or wedge, and are maintained in their respective places by a cross bar, C C, at each side at or near the base; such cross bars being secured by other pins, D D, like the first one passing through the ends of the cross bars, C, and through the lower ends of the several pieces of firewood, A. The whole or a part may or may not be dipped in resin or other inflammable material; and if desired a few shavings, as shown at E in the drawings, may be introduced into the hollow of the cone, wedge, or pyramid, and maintained in place by passing a piece of string round the whole, as shown.



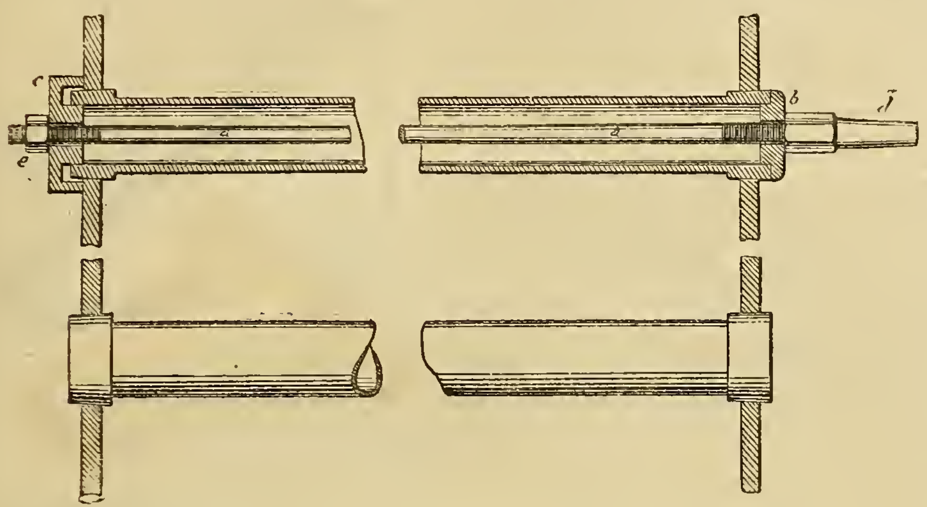
New Targets.—The secretary of state for War has sanctioned the construction of another target on the Chalmers system. This target, which is being made at the Atlas Works, is to be similar in arrangement to the original Chalmers target made at Millwall in 1863. In both targets, behind the armour plates, there is, first, a compound backing of edge plates of thin iron and planks of timber; then, a second armour plate; and, finally, a cushion of timber planking between the second plate and the skin, or inner plate of the target. The main difference between the targets of 1863 and 1868 is therefore in dimensions thus:—

	1863. Inches.	1868. Inches.
Thickness of armour plate,.	$3\frac{3}{4}$	$4\frac{1}{2}$
Depth of compound backing,.	$10\frac{3}{4}$	$13\frac{1}{2}$
Thickness of edge plates,	$\frac{3}{8}$	$\frac{5}{8}$
" second plate,	$1\frac{1}{4}$	2
" cushion, .	$3\frac{3}{4}$	6

The other new target, now being constructed at the Cyclops Works, is to be the same as the 8-inch *Warrior* target—an 8-inch plate upon a backing of 18 inches of teak, with an inner skin $\frac{3}{4}$-inch thick. This, and the new Chalmers target, are to be of the same weight per square foot, and the same depth of structure. It is intended, we understand, to test their relative resistance. The 9-inch gun, with Palliser shot, penetrated the 8-inch *Warrior* target two years ago. It remains to be seen whether the same weight of materials differently distributed will give a better resistance. In any case such a competitive trial will be looked forward to with much interest.

The Submarine Railway between England and France.—An interesting document regarding the proposed submarine railway has been lithographed. It is an address presented to the Emperor Napoleon by about one hundred influential noblemen, M.P.'s, and other gentlemen, praying his Majesty to support the projected tunnel between England and France. The copy of the address contains *fac-simile* signatures of the memorialists. The address is as follows:—"Sire,—We, the undersigned, subjects of her Most Gracious Majesty the Queen of England, are informed that a committee of French and English gentlemen propose to ask your Majesty's support for the construction of a submarine tunnel intended to connect the railways of England with those of France, an eminently desirable work, which has become necessary to facilitate the social intercourse which has so rapidly increased of late years between the inhabitants of the two countries, and for the development of their trade and commerce. The realization of this noble enterprise, by strengthening the bonds which unite two great peoples, will be of immense advantage to both countries, and a memorable example of concord offered to other nations. We have the most earnest wish for the speedy success of this fruitful work, and we hope that your Majesty will deign to grant it your august protection. We are, Sire, with the most profound respect, your Majesty's most obedient humble servants." The following signatures are amongst many others appended:—Argyll, Sutherland, Elcho, M.P. for Haddingtonshire; Robert Dalglish, M.P. for the city of Glasgow; H. Miller, M.P. for Leith; R. L. Gower, M.P. for Sutherlandshire; Lorne, M.P. for Argyleshire; and James Lumsden, Lord Provost of Glasgow.

Berendorf's Movable Boiler Tubes—Movable tubes are now substituted for fixed tubes in the majority of new boilers constructed, and from their great advantage it is not difficult to foresee that ere long they will entirely supersede them. Various systems of this nature have been proposed to fulfil the conditions required in boiler tubes, one of which we illustrated a short time since.* M. Berendorf, engineer, Paris, has recently proposed a method of effecting this object, which seems to possess some advantages. The tubes are perfectly straight in the interior throughout their entire length, and are merely strengthened externally at both ends. They are inserted into the plates in the following manner:—There is introduced into the tube an iron rod, *a*, having a screw thread cut therein at each end, and carrying washers, *b* and *c*, and nuts, *d* and *e*, one washer bearing against the end of the tube, and the other resting on the boiler plate. The washer, *c*, is applied against the plate in which the hole for the reception of the tube is smallest on the outside, and the nut, *e*, screwed up; the tube is thus drawn and introduced by pressure, and in order to facilitate the operation, a few blows of a hammer may be applied to the nut, *d*. In order to withdraw the tube, the operation is reversed; the washer, *c*, with its nut, are applied to the plate having the larger hole on the outside, and it is simply necessary to turn the nut, *e*, as in the case of the insertion of the tube. This arrangement, whilst it facilitates the operation of mounting the tubes, obviates the inconvenience resulting from the use of bushes inside, which diminish the size of the orifices, and also admits of the tubes being cleaned in a ready and efficient manner.



Mowing Machines.—A large gathering of farmers recently assembled at Winchester to witness a trial of English and American mowing machines, instituted by the Hampshire Agricultural Society. The deepest interest was manifested in the proceedings, these labour-saving machines having now become a necessity in British agriculture. Seven machines, each drawn by a pair of horses, competed for the prizes. The leading makers were on the ground to superintend the working of their machines. Mr. Wood, jun., who was over from America, and Mr. Cranstone, represented the celebrated machine of Walter A. Wood. The American clipper mower was exhibited by the Reading Ironworks Company. Mr. Phillips, from Grantham, had charge of Messrs. Hornsby's paragon mower. The partner of Mr. Samuelson, of Banbury, managed the eclipse machine. Mr. Kearsley, of Ripon, was also a competitor. Mr. James Howard, of Bedford, entered the lists for the first time with Messrs. Howard's new British mower. After the machines had gone a few rounds, it was evident to the spectators that the first prize would fall either to Wood's American or Howard's new British mower. At the completion of the plots, the judges selected the two latter as the best, and ordered a second trial between them. The work of both was so perfect that the judges had great difficulty in coming to a decision. However, as the Americans finished the work in a few minutes less time, they placed Wood's first and Howard's second, giving Messrs. Burgess & Key a third prize.

Paris Central School of Arts and Manufactures.—The minister of Agriculture, Commerce, and Public Works has just issued the programme of the conditions of admission to this important school, which is open to foreigners as well as natives of France, and on the same conditions. Diplomas of "Engineer of Arts and Manufactures" are granted annually by the minister to those pupils who are recommended by the council of the school as having passed through all the examinations in a satisfactory manner, and certificates of capacity are granted to those who have exhibited sufficient knowledge in the most important departments of instruction. All the pupils are out-of-door scholars, and no uniform, nor any other distinctive mark, is worn by them. The course of study occupies three years, and the fees, including the costs of experiment, are 800 francs (£32) per annum, half the amount being paid on entering, and the remainder, in two equal instalments, in the months of February and May. The only other conditions are—the deposit of a sum of 35 francs to defray any losses or injuries done by the pupils' negligence, and the purchase of the necessary books and instruments, which may be had at the school, at rates fixed by the director. In the case of pupils, natives of France, whose families are not in a condition to defray the costs of the school, subventions are granted by the state, under certain conditions; but this, of course, does not apply to foreigners. All pupils must pass an examination before admission, and these examinations take place twice in the year, namely, in July and October. The programme for admission consists of compositions and oral examination in the following subjects:—French language; arithmetic; elementary geometry; algebra, as far as the general theory of equations exclusively; rectilinear trigonometry; analytical geometry; descriptive geometry; physics; that part of the usual course of the lycées which precedes heat; chemistry; rudiments of metallurgy; natural history; freehand, linear drawing, and tinting. In addition to these, the pupil is examined also in the general subjects, as in other superior schools. Full particulars are to be obtained by application to the secretary of the school. The pupils must have attained the age of seventeen on the first day of the year of application, and must produce testimonials of good conduct, and a certificate of vaccination.

Horse Shoes.—Professor Gamgee, of the Albert Veterinary College, has patented certain improvements which relate to the manufacture of horse shoes, whereby a firmer foothold is afforded to the horse whether the foot be pressing forward or backward; and also to a peculiar tool to be employed in the manufacture of the improved shoes. In carrying out the invention, certain indentations, depressions, notches, and sharp angles are arranged, as hereinafter described, on the inner margin of the web, on the lower or ground surface of the shoe. When each half of the shoe in the process of forging has been drawn into shape, and either before or after it has been "fullered" or "stamped" in the ordinary way, the tool hereinafter more particularly described and referred to as the "gouge," is employed in order to produce oblong semi-oval depressions, directed obliquely from the front backwards, at the interior part or inner margin of the web, on the ground surface of the shoe, and to produce other like depressions directed obliquely from behind forward from each posterior portion of the shoe; the small burr of iron displaced by the "gouge" at each depression being cut off by a tool, which is called the "cutter," on a small cutting block or surface of soft iron, so as not to injure the "cutter," which block may be inserted into and removed from the ordinary anvil as required. These depressions may vary in position and number according to the size and shape of the shoe; it is preferred, however, to use two directed obliquely backwards and inwards on either side of the toe, leaving the web of the shoe strong at the toe or centre, and two more close to each heel, directed forwards and inwards, thus also leaving the quarters of the shoe strong. In manufacturing race-horse plates or light shoes according to this invention, the plate is made with a "creasing" tool or swage in the ordinary manner; and then by the aid of an ordinary cold chisel, jag the inner margin of the web on the lower ground surface so as to produce sharp points, which in the fore part of the plate are raised from the rear forwards, and in the hind portions of the plate are raised from the front backwards. With these points, which should be two, three, or four in number on each or either side of the plate, there may or may not be combined, as desired, a small "turn up" of one or both heels. The peculiar tool hereinbefore referred to as the "gouge," consists of a steel flat-faced punch, which should be of a semicircular or nearly semicircular or semi-oval transverse section. It is held by a convenient handle over the web of the shoe, and is then struck by a hammer. If desired, all the indentations or depressions may be simultaneously made by means of a die or block of the same size as the "mould" or shoe blank, provided with the desired number of projections or punches according to the number of depressions or indentations to be made in the shoe. The "mould" or blank may be placed upon a bed and this die laid upon it and then brought forcibly down, so as to indent the metal, by direct-acting steam or hydraulic power, as in the steam hammer or hydraulic forging press. Fig. 1 of the engravings represents a plan or under side view of a horse shoe for ordinary purposes; and fig. 2 is a section of the same, taken through the centre or toe thereof. The tools required in making the improved shoe are the ordinary "fuller" for "fullering" the shoe, and the ordinary "stamp" and pritchel for making the nail holes. The additional special tools required are the "gouge" (shown in perspective and face view at figs. 3 and 4), and the "cutter" and "cutting block," not shown in the engravings. The shoe is worked in the ordinary manner from new bar or from old iron, the web being forged of equal thickness and breadth of cover throughout its full extent, as shown in figs. 1 and 2, with the exception of the hind parts or heel of the shoe, where the breadth may taper slightly, as shown in fig. 1; but the substance or thickness of the iron is not to be diminished by seating or bevelling out as heretofore. In making the shoe, the outer half is first forged and "fullered," and the nail holes "stamped" and pritchelled, after which the depressions, *a a*, *a' a'*, are made in the inner margin of the web of the shoe when

Fig. 1.

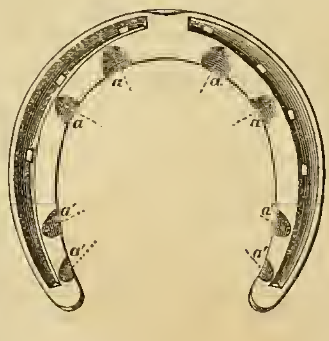
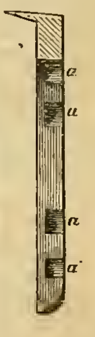
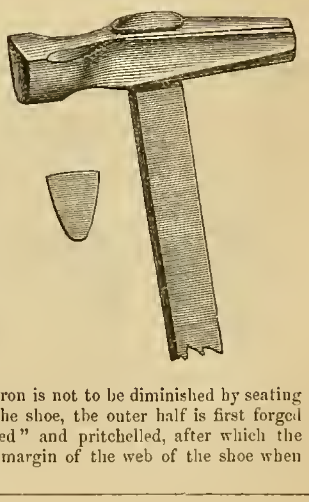


Fig. 2.



Figs. 3 and 4.



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* Langlois' Movable Boiler Tubes, part 38, p. 41.

hot, by means of the flat-faced steel tool (fig. 3) which is called the "gouge," such tool being held by its handle in the proper position, and struck by a sledge hammer. The depth of these depressions should be about three-fourths of the substance or thickness of the iron, as shown in fig. 2; the front depressions, *a a* (by preference, two on each side of the forward part of the shoe), being directed obliquely from the heel forwards, and the hinder depressions, *a′ a′* (by preference, two on each half of the shoe), directed from the front or toe backwards. The half shoe is then placed in a vice, and completed by filing off any roughness left after the cutter has operated; the half of the shoe is then placed in the fire and heated preparatory to being hammered up, and the process of making and finishing the inner half to be followed is a mere repetition of that for making the outer half, with the exception that three nail holes only, in lieu of four, will be required to be stamped. Fig. 5 is an under side plan of a light shoe or racing plate constructed according to this invention; and fig. 6 is a section of the same, taken through the toe or centre thereof. In making this plate the best charcoal nail-rod iron is worked through the swage and then cut off into lengths in pairs averaging from 9 to 12 inches for each plate, which are to be turned and forged to the proper shape to fit the respective feet for which they are required; the nail holes are then stamped and the plate filed up in the ordinary manner for application. The otherwise finished plate is then placed in a vice, and four well-defined jags or cuts, *a a*, *a′ a′*, are made on the inner margin of the web of each half or side of the plate, by means of an ordinary cold chisel and hammer, the forward jags, *a a*, being produced by making the cut from the back towards the front of the plate, and the rear or hinder jags, *a′ a′*, by making the cut in the reverse direction, the result being the raising of sharp teeth or pointed projections in opposite directions at the front and rear portions of the plate, as will be clearly seen on referring to figs. 5 and 6, whereby, as also in the case of the peculiarly disposed depressions shown in the shoe (figs. 1 and 2), a better foothold is afforded to the horse, the hinder depressions or sharp projecting angles tending to prevent the foot from slipping forward when the heel is brought to the ground, and the forward depressions or sharp projecting angles preventing any back slip when the toe is acting.

Fig. 5.

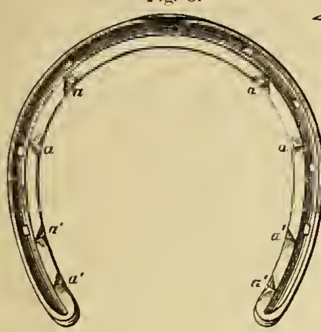
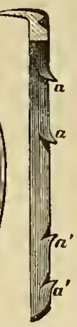


Fig. 6.



Mr. Sillar's Sewage Process at Leicester.—Mr. Sillar's partner (as we understand he is) writes to the papers concerning the sewage experiments at Leicester. The total quantity of sewage treated was 10,637,000 gallons, being nearly one half of the Leicester drainage. The following table shows the comparative analyses of the sewage before and after its treatment by the A B C process. The figures are the average of sixteen analyses of as many samples taken at intervals of one hour:—

	Grains per Imperial Gallon.	
	Sewage.	A B C Water.
Organic matter,	42·56	10·20
Mineral matter,	69·36	58·41
Total solid matter,	111·92	68·61

The actual quantity of the manure obtained by the process will be ascertained when it is thoroughly dry. It is estimated, however, to exceed 90 tons, or 1 ton per 120,000 gallons of sewage. The analysis of an average sample of it, dried in the laboratory until fit for sale, is as follows:—

Water,	14·00
Organic matter,	47·10
Alkaline salts,	4·76
Earthy salts, containing phosphoric acid 1·31,	12·71
Silica,	21·43
	100·00

The nitrogen contained in this sample is considerably in excess of that given in the approximate analysis. Its equivalent in ammonia is more than 4½ per cent., and the value of the manure will therefore be proportionably increased. The estimate of the cost is 8*s.* 7*d.* per 100,000 gallons.

Lacing Boots.—Messrs. Shurtleff & Church, of Providence, Rhode Island, U. S., A., have patented an invention which relates to a peculiar attachment and mode of securing the same to boots and shoes, gaiters, and other articles of dress, with a view to facilitating the lacing thereof, whereby a neat appearance is presented, and, in the case of boots and shoes, the bottoms of the trousers, or other articles of dress worn over the boot or shoe, are less liable to be injured or frayed by rubbing against the attachments employed. Fig. 1 of the engravings is a vertical section of the improved lacing attachment, fig. 2 is a perspective view of the lacing button and hook, and fig. 3 represents a perspective view of a boot provided with this improved lacing device. In carrying out this invention it is proposed to employ a peculiar attachment, which the inventors term a "button-hook," as it combines the appearance of a rounded button or stud, with the properties of a hook or staple. It is preferred to make this attachment from a single metal blank, which is struck up or shaped by two or more successive blows in dies of the requisite shape. The upper part of the attachment consists of a thin brass or other metal disc, A, stamped or struck up in dies so as to assume a concavo-convex form, the convex side being the upper or outside when fixed in the boot or shoe. With this cap or button there is connected at its periphery a shank, which consists of a strip of metal, C, bent under the cap and then turned back in the opposite direction, so as to form a hook or staple, the interior of such hook being rounded off at *e*, so as not to cut or wear the lace which is hooked on to it. That part of the bent shank which rests upon the surface of the upper of the boot or shoe is of a disc shape, and may be either slightly rounded or flat, so as to adapt itself readily to the surface of the boot or shoe. To this disc are connected two or more prongs, D, D, which pass through the leather and are clinched on the opposite side by bending them back after insertion. If desired, the cap or rounded button may be soldered at its periphery to the shank, in lieu of making it in one piece as described. These attachments are inserted in two parallel rows, one row on each of the two parts of the upper to be brought together by the lace, the rows being also parallel to the junction edges of the leather. The lacing cord or cords pass externally, zig-zag fashion, from hook to hook, and thus draw the parts neatly together. It is obvious that this same attachment is equally applicable to gaiters and other articles of dress capable of being fastened or closed by laces.

Fig. 1.

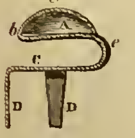


Fig 2.

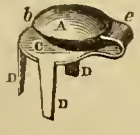
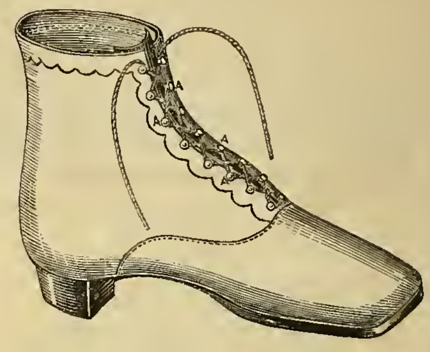


Fig. 3.

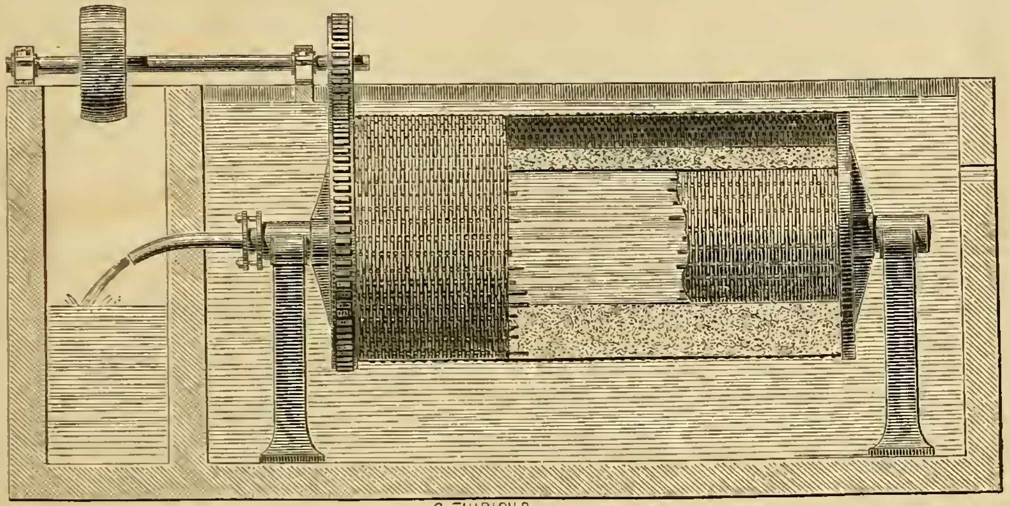


The Yorkshire Iron Trade.—The West Yorkshire Iron and Coal Company have now opened their new blast furnaces at West Ardsley. These works are situated about midway between Leeds and Wakefield, on the line of the Great Northern Railway at its junction with the Bradford branch, and a little to the north of the Methley Junction. The works are planned for a range of four blast furnaces, of which two are already completed. There are two sets of heating stoves (eight to each set) for heating the blast; an engine-house containing two blowing engines; a set of five boilers for supplying steam for blowing, and also for working the hoist by which the materials for smelting are lifted to the top of the furnaces; a pump-house for two of Cameron's pumps, for forcing the water up to a large tank covering the engine-house; and a range of bunkers, or depots, with locomotive incline, for holding a stock of material. The company are lessees from the late earl of Cardigan of a large field of clayband ironstone of the well-known measures of the district, as well as a seam of fine coal adapted for coking and smelting purposes. They are also lessees of, and have opened out, an ironstone mine in Lincolnshire (on the estate of the earl of Yarborough), where a remarkably pure hydrated ironstone is obtained out of the green sandstone measures. This, when smelted in suitable mixture with the local clayband stone, produces a very superior pig iron, which is particularly well suited for the better purposes of the district. The lime used for fluxing is the best Skipton rock.

The Electric Telegraph.—M. Neumann, in the Austrian report of the Paris Universal Exhibition in 1867, states that the telegraphic lines in the whole world are 49,255 geographical miles long; there are in Europe 8000 offices, and 4000 in the other continents. It has been necessary to employ for the conducting wires 1,300,000 cwts. of iron; the expense of establishing all the lines is estimated at 416,000,000 francs.

Utilization of Sewage.—The report of the sewage irrigation experiments made at the Lodge Farm, Barking, by the Metropolitan Sewage and Essex Reclamation Company, for the year ending August 31, has just been presented to the directors by the manager. The demand for the rye-grass, to the growth of which one-fourth of the acreage is devoted, now exceeds the supply, as its value is beginning to be appreciated. That its use in cattle-feeding is most satisfactory, may be gathered from the fact that two young steers fed exclusively on the sewage-grown grass since May 18 had increased in weight by August 7 from 6 cwt. and 7¾ cwt. to 7¼ cwt. and 9¼ cwt. respectively. Experiments of a very interesting character are detailed, illustrative of the remarkable fertilizing power of the sewage on land of the poorest and most sterile nature. And whereas it used to be one of the strong points urged against sewage irrigation that it was good for nothing but the growth of rye-grass, the manager of the Lodge Farm is able to speak now of wheat, rye, oats, mangold, cabbage, turnips, sugar-beet, parsnips, potatoes, &c., all yielding most prolific crops from poor land receiving no other manure than the sewage. It is confidently asserted that no amount of ordinary manure could produce six or seven crops of grass a season, weighing from 6 to 12 tons each. In the case of mangold, also, the knowledge that two dressings or floodings of sewage, consisting of from 200 to 300 tons per acre each, is capable of producing a crop of from 50 to 60 tons per acre, enables a comparison to be drawn with the ordinary crop of from 20 to 25 tons produced with a good dressing of farmyard dung. The crop of wheat grown last year without any manure was about 3½ qrs. to the acre; this year the yield with sewage was 5½ qrs. Not more than 1·350th of the whole of the sewage of North London is used on the Lodge Farm in a year; and as the results are so triumphantly successful, it may be hoped that the farmers of South Essex will begin to avail themselves of the means offered to them by the company for enriching their land with the valuable fertilizing stream which at present passes away in waste to the ocean.—*The Lancet.*

Lacroix' Rotatory Filter.—M. J. Lacroix, paper manufacturer of Angoulême, has recently invented a method of effecting the cleansing of the clarifying matters contained in filters, by imparting to the filters a rotatory motion. It is evident that if a space is left in a horizontal cylindrical filter, unoccupied by filtering matter, the rotation of the apparatus will, by agitating the water contained therein, and rubbing together the filtering materials employed, such as gravel, saw-dust, &c., thoroughly cleanse the same from all impurities. The annexed engraving is a sectional elevation of a filter constructed upon this principle. It consists of two concentric envelopes or casings, as shown, composed of perforated metal plates or staves, or as the inventor prefers, of a metal frame covered with a species of wire gauze known as "Repp's metallic cloth," as shown in the figure. This arrangement admits of the use of filtering matters of small size, such as saw-dust, &c. The two envelopes are connected at their extremities by metal ends provided with ribs, the centre of which carries an axis around which the filter turns in the bearings shown. The figure shows the filter immersed in the liquid to be filtered, contained in a stone trough; the liquid is maintained at a constant level, and by the pressure that it exerts upon the filter it penetrates through the clarifying materials inclosed between the two concentric envelopes, and passes through a central tube into a reservoir, the liquid contained in which is always maintained at a lower level than that of the unfiltered liquid in the other trough. When the filter is rotated for the purpose of cleaning, the course of the discharge pipe which conveys away the filtered water is diverted, in order to prevent the water which escapes and carries away with it the impurities from the filtering substances from being mixed with the water previously filtered. In order to effect the cleansing in a more expeditious and perfect manner, it is found desirable to lower the level of the impure water, and raise that of the filtered water. By this means the direction of the filtration is reversed, and the impurities which adhere to the filtering substances are quickly removed and carried out of the apparatus. With a view to facilitate the changing of the relative levels of the troughs containing the filtered and unfiltered water, an orifice is provided in the latter trough which admits of the escape of a portion of the water contained therein, whilst the inlet aperture formed in one of its sides is closed to intercept the supply. We understand that M. Lacroix has been in negotiation with the authorities of Angoulême for the application of his system to the purification of the water of that town.



Ch. THIRION, Dir.

American v. Clyde Shipbuilding.—We have published at different times communications on the subject of establishing American steamship lines to Europe, and have endeavoured to stimulate enterprise in the matter. We have pointed to the surprising success of the British, German, and French lines, and asked why a portion at least of the vast trade they do with this country should not be done in American steamships. Not only do British capitalists who enter into the steamship business go to the Clyde for their vessels, but foreigners do the same, because they can get finer and cheaper ones there than at home. There are few of the vast fleet of fine steamships traversing the Atlantic in the German and French lines, as well as in the British Cunard and Inman lines, that were not built on the Clyde, and simply because this was the best place to go for them. The companies went to the best market, without any regard to the nationality of the builders or where the materials came from. Once constructed and afloat, these vessels become French or German, as the case may be, and have nothing of a British character about them. If they could build steamships as cheap and good in France or Germany, they would construct them there, no doubt; but finding they cannot, they have sense enough to get them from the Clyde, and give them a French or German nationality afterwards. Here, then, is a great disadvantage Americans labour under, and one of the principal causes why we are not able to rival the British, French, and Germans in Atlantic steamship enterprise. In the attempt to protect a few American shipbuilders through the law prohibiting registers to foreign-built vessels we are destroying the maritime interests and progress of the nation. This narrow-minded and short-sighted policy gives the vast carrying trade between this country and Europe to foreigners. Out of the numerous fleets of steamships crossing the Atlantic, some of which are arriving and leaving our ports daily, there is not one bearing the American flag. Nor is there one to the South American states on either side of the Continent, though they are our near neighbours, and though England and other European countries have probably as many as fifty running to and from the different ports of South and Central America. What a vast amount of wealth is thus drawn to Europe, and to England principally, from us and our neighbours which ought to remain in the United States! The stupid registry law does not promote shipbuilding, and is fast destroying the maritime interests and character of our country. With greater natural advantages than any other country, with an extraordinary stream of emigration coming all the time, with thousands of Americans continually crossing and re-crossing the Atlantic, and supplying the largest amount of materials for commerce, we are still nowhere in the race of ocean steamship navigation. Nor will any effort to build up steamship lines or enterprise by government subsidies prove successful. It might enrich a particular company. But it would prevent rivalry. It would create a monopoly and prevent other shipping capitalists from entering into the business. It would be unfair and contrary to the spirit of our institutions. Special legislation in favour of particular individuals or companies is wrong, and tends to injure rather than promote the general interests of the community with regard to either the shipping or any other business. Incidentally and generally everything possible should be done to encourage steamship enterprise, such as by giving mail contracts and by taking off taxes that bear heavily on shipbuilders; but there should be no subsidies and loans of the public credit to favored individuals. Let us get our steamships from the Clyde or anywhere else at the cheapest rate, and give them American registers. That is the way to build up American lines, and by doing this the wealth of the country would be increased and our commerce extended. With the growth of the country and increase of wealth, our iron mines and manufactories would be developed, and in the course of a few years we might be able to rival England in shipbuilding. Let us not lose present opportunities, and see our mercantile marine depressed for the sake of a narrow and foolish policy of protection, which is neither in accordance with our institutions nor the spirit of the age.—*New York Herald.*

Carons' Safety Appliance for Lifting Apparatus.—The annexed engravings illustrate an appliance designed by M. E. Caron, C. E., Paris, with a view to prevent those serious accidents which frequently occur with lifting apparatus, from the breakage of a chain when raising goods. It consists of a block or holder C (fig. 1), carrying at its lower part the hook, A, and provided with two cheeks, B B′, having holes formed therein in which to place the chain which passes over the pulley, P (fig. 2), fixed to the pulley-holder. To the cheeks, B B′, are jointed levers, L L′, formed in one piece with jaws, M M′, which are drawn by springs in order to bring the levers into a horizontal position; these levers are provided at their extremity with rollers, G G, which enable the chain when not broken to hold the levers constantly in an elevated position, and consequently to cause the jaws to open in order to admit of its passing between them and the cheeks of the holder. If then either branch of the chain becomes slackened in consequence of a rupture of any one of the parts on which the holder depends, one of the levers, L L′, will drop and press the chain against either the cheek, B, or B′, as the case may be; and this motion is performed with great rapidity by the action of the bell-springs, R and R′. The holder from this moment will remain in its place, sustaining the load carried by the hook. For example, if the length, A (fig. 2), should happen to break, the lower end of the chain will drop, and its effect on the lever, L′ (fig. 1), cease; the jaw, M, will then close under the action of the spring, R, and the load will remain suspended by the lengths,

Fig. 1.

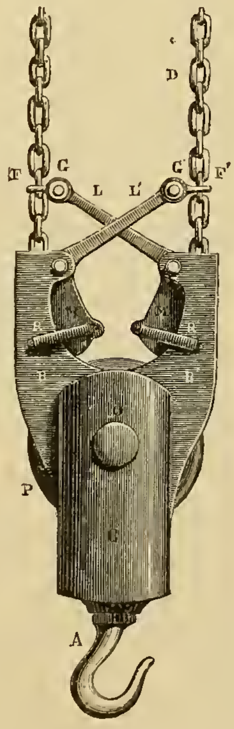
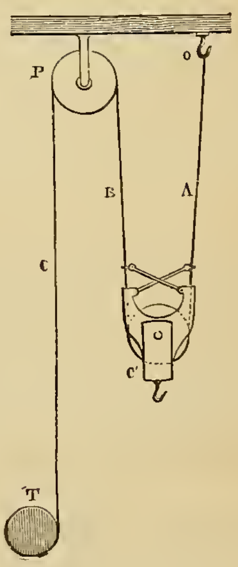


Fig 2.



B and C, which remain intact. Another chain may then be substituted for the fractured one, and the apparatus again put in working order. The stroke of the lever being very small, the arresting of the chain is effected instantaneously without any shock. Should a fracture occur in the length, B, a similar effect is produced; the lever, L (fig. 1), drops, the jaw, M′, closes, and the load is supported by the length, A. In the case of the length, C, breaking, or B and C both giving way at the same time, or should the chain escape from the pulleys, or from the barrel, or the support of the pulley, P, fail, the load will be suspended by the length, A, as in the preceding example; but if the hook which supports the upper end of A should give way, the effect will be the same as in the case of a rupture of A itself. It will naturally suggest itself, that in the event of an accident the weight of the load will be thrown upon one length of chain, which will be then subjected to double the strain, and as the fracture of a chain is usually caused (except in the case of a defect in one of the links) by its having to support a greater weight than it was designed to sustain, it is evident that a single length of chain could not bear the strain to which it would then be subjected, and must inevitably fail. It will be necessary then to make use of a chain of twice the strength which would be required in the ordinary way. This precaution will, it is true, diminish the utility of this apparatus, which, however, will still be necessary, in case one of the supports of the chain should fail, or of rupture occurring from a defect in one of the links.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

11th September, 1868.

2797 O. C. Evans, Lambeth—Constructing girders
2798 B. Dobson and W. Slater, Bolton—Wood-cutting machinery
2799 W. Thompson, Dublin—Mixing tea
2800 B. D. Godfrey, Chancery Lane—Boots and shoes
2801 J. Hudson, Stockport—Self-acting "tilts" for casks
2802 J Bullough, Accrington—Warping machines
2803 E. T. Hughes, Chancery Lane—Annealing gauze wire.—A com.
2804 B. Gardiner, Bradford, and T. H. Faulkner, Milk Street—Umbrellas
2805 G. Bischof, Allée Bonn—Separating copper from its solutions
2806 J. Roberts, King William Street—Portable stove
2807 J Roberts, King William Street—Horse shoes
2808 G. Bower and W. Hollinshead, St. Neots—Gas engines
2809 M. Henry, Fleet Street—Combined apparatus for weighing and lifting.—A com.

12th September, 1868.

2810 H. B. Woodcock, Low Moor—Manufacturing metal for axles
2811 C. Turner, Preston—Furnaces
2812 A. W. Rodger, Stewarton—Bonnets
2813 F. Warner, Jewin Crescent—Constructing wells
2814 E. Turner, Bristol—Packing for pistons
2815 W. R. Lake, Chancery Lane—Manufacturing brushes.—A com.
2816 J. C. Coombe, Barnsbury, and S. G. Gregg, Lombard Street—Preserving iron from the corrosive action of salt water

14th September, 1868.

2817 J. Coppard, Lower Park Street—Machines for mincing meat
2818 W. R. Lake, Chancery Lane—Substitute for hair stuffing.—A com.
2819 C. E. Brooman, Fleet Street—Metallic plates.—A com.
2820 F. S. Ultzen, Victoria Street—Generating carbonic acid.—A com.
2821 C. E. Pommier, Paris—Size for paper
2822 M. A. Soul, Leadenhall Street—Spring pendulums.—A com.
2823 J. D. Pinfold, Rugby—Grinding grain
2824 J. Hetherington, Manchester—Machines for winding yarn.
2825 H. J. Turnbull, Sunderland—Preserving the bottoms of iron ships
2826 J. Fenwick, Bedford—Annealing ovens
2827 J. Hewes, Chelsea—Advertising
2828 A. M. Clark, Chancery Lane—Bottling liquids.—A com.

15th September, 1868.

2829 E. Vickers, Goswell Road—Manufacturing hats
2830 C. D. Abel, Chancery Lane—Securing buttons to articles of dress.—A com.
2831 M. Benson, Manchester Square—Steam pumping engines.—A com.
2832 E. Sarjeant, Birmingham—Gasaliers
2833 H. Jewitt, Kentish Town—Toys.—A com.
2834 C. De Bergue, Westminster—Gas cooking stoves
2835 F. Brady, Regent's Park—Sweeping machines
2836 J. H. Schucht, Bedford Square—Pianofortes
2837 W. Campion and G. Hall, Nottingham—Washing and bleaching
2838 J. Edmondson, Manchester—Fastening metallic hoops
2839 G. Davies, Lincoln's Inn—Machine for cleaning coffee.—A com.
2840 R. Martin, Westminster Bridge Road—Apparatus for cleaning boots
2841 A Rooker, Lamb's Conduit Street—Curtain rings
2842 W. R. Lake, Chancery Lane—Covering for walls.—A com.
2843 E. Hensser, Jewin Crescent—Locks for travelling bags.—A com.
2844 W. Durham, Currie—Preserving wire webs from corrosion
2845 R. Hodson, West Ham—Punching machine

16th September, 1868.

2846 C. Havard and M. Q. Harmony, Blackfriars—Preserving meat
2847 J. Orrin and T. Geer, Little Britain—Apparatus for cutting the edges of books
2848 J. Horrocks, Ainsworth—Looms for weaving
2849 F. F. Greenwood, Hornsey—Fastenings
2850 G. R. Samson, Oxford Street—Pianofortes
2851 J. Walmsley, Preston—Communicating in railway trains
2852 H. Marrian, King's Heath—Weighing machines
2853 J. De Masy, Bruxelles—Cases for holding railway tickets
2854 A. M. Clark, Chancery Lane—Electro-magnets.—A com.
2855 G. B. Sharpe, Llanelwedd Builth—Fire-grates
2856 J. B. Spence and R. R. Kelly, Manchester—Pigments
2857 W. Betts, City Road—Capsuling bottles
2858 R. Dea, Birmingham—Pulverizing ploughs
2859 W. R. Lake, Chancery Lane—Toys.—A com.

17th September, 1868.

2860 T. Beards, Buckingham—Steam ploughs
2861 J. Davey, Sheviock—Ploughs
2862 W. T. Watts, Birmingham—Annealing raised hollow vessels
2863 W. E. Newton, Chancery Lane—Raising water.—A com.
2864 A. F. Campbell, Great Plumstead—Ships
2865 W. R. Lake, Chancery Lane—Explosive compounds.—A com.
2866 H. Wilson, Stockton-on-Tees—Water-closets
2867 G. H. Barth, Bayswater—Supplying gases for medicinal purposes
2868 T. J. Jones, J. Brandwood, and J. Wren, Manchester—Furnaces
2869 J. H. Johnson, Lincoln's Inn Fields—Furnaces.—A com.
2870 J. H. Johnson, Lincoln's Inn Fields—Mode of advertising.—A com.
2871 R. Smith, Islington—Preventing the fouling of ships' bottoms
2872 W. Clissold, Stroud—Feeding wool to carding machines
2873 J. Head, Ipswich—Wire fences.—A com.

18th September, 1868.

2874 C. H. Hudson, New York—Washing apparatus
2875 E. T. Hughes, Chancery Lane—Wringing machines.—A com.
2876 W. Cross, Paddington—Carriage door stops
2877 H. Vansittart, Richmond—Screw propellers
2878 W. Clark, Portman Square—Spring boots for horses
2879 E. Tempelhoff, Posna—Potato planting machine
2880 E. T. Hughes, Chancery Lane—Polishing glass.—A com.
2881 W. Needham and J. Kite, Vauxhall—Depurating fluids
2882 J. Smith and J. Dewdney, Leadenhall Street—Steam boilers

19th September, 1868.

2883 W. H. Hughan, Newton Stewart—Treating sewage
2884 G. Bernhardt, Radcliffe—Preparing fibrous materials
2885 T. Beruey, Bracon Hall—Defensive armour
2886 M. Macdermott, Kensington—Street-lamp reflector
2887 J. Blakey, Leeds—Repairing boots and shoes
2888 F. Dyer, Camden Town—Hot-water apparatus
2889 W. Haynes, Bolton—Dressing leather
2890 J. Brown, Huddersfield—Extracting water from wool
2891 L. Desens, Charing Cross—Safety lamps
2892 G. Innes, New Cross—Rifling machines
2893 B. Dickinson, Darjeeling—Treating tea-leaves
2894 B. Dickinson, Darjeeling—Desiccating the leaves of plants
2895 N. Jarvie, Greenwich, and W. Miller, Glasgow—Manufacturing oakum
2896 H. Foster, Bermondsey—Graining leather
2897 G. Sanders, Birmingham—Safety valves.—A com.
2898 J. H. Johnson, Lincoln's Inn Fields—Illuminating gas.—A com.
2899 W. C. Woodcock, Sheffield—Baker's ovens

21st September, 1868.

2900 W. E. Wiley, Birmingham—Cartridges for breech-loading fire-arms
2901 N. Stevenson, Wimpole Street—Ornamental fountains
2902 C. Wheeler, Speenhamland—Tap for liquids
2903 J. Lorkin, Norwood—Coffee pots
2904 P. E. L. W. Stockmann, Russel Square—Tents
2905 J. Kirk, Woolwich, and J. Batstone, Westminster—Armour plates for vessels
2906 J. G. Piton, Cornhill—Hoisting apparatus
2907 C. Vero, Atherstone—Manufacturing hats
2908 S. Fox, Sheffield—Umbrellas

22nd September, 1868.

2909 F. W. Fox, Bristol—Locomotive engines
2910 W. H. J. Grout, Commercial Road—Moulds for tobacco pipes
2911 W. L. Wise, Westminster—Axle boxes for railway carriages.—A com.
2912 W. J. Murphy, Cork, and J. B. O'Hea, Greenwich—Rifled barrels for small arms.
2913 C. E. Brooman, Fleet Street—Registering the speed of ships.—A com.
2914 B. C. Scott, Kingston—Measures for measuring liquids
2915 W. Leatham, Leeds—Preventing accidents to steam boilers
2916 R. Harling, Silvertown—Telegraphic instruments

23rd September, 1868.

2917 T. Lucas, Bury, and W. Grimshaw, Ashton-under-Lyne—Preparing wool to be felted
2918 F. C. Calvert, Manchester—Dyeing yarns
2919 E. H. Prentice, Stowmarket—Treating sewage
2920 J. Macintosh, Regent's Park, and W. Boggett, Chelsea—Elastic bands
2921 E. W. Halliday, Hammersmith—Lubricating cylinders
2922 H. Lomax, Over Darwen—Sewing machines
2923 H. J. B. Kendall, Great Winchester Street—Composition for protecting ships' bottoms.—A com.
2924 A. Barclay, Kilmarnock—Combining barometers and thermometers with watches
2925 A. Booth and J. Harrison, Staleybridge—Sewing machines
2926 J. H. Glew, City Road—Button holes for boots
2927 C. Heptonstall, Huddersfield—Looms for weaving
2928 W. Thomas, Carnarvon—Circular saws

24th September, 1868.

2929 A. M'N. Wier and M. A. Wier, Bayswater—Transmitting motive power
2930 H. Woods, Salford—Heating water by steam
2931 C. Hengst and H. Watson, Chelsea, J. B. Muschamp, Upper Thames Street, and N. Wilson, High Holborn—Carburetted hydrogen gas
2932 W. Dunn, Newington Green—Dispensing with the usual fastenings in repairing tubes
2933 E. Death and J. Ellwood, Leicester—Pumping apparatus
2934 E. Death and J. Ellwood, Leicester—Cutting leather
2935 D. Cowan, Long Acre—Float valves
2936 J. Fry, Marylebone—Carriage wheels
2937 C. Catlow, Burnley—Looms for weaving
2938 J. F. Wanner, Middlesex Hospital—Ornamenting fabrics.—A com.
2939 W. T. Watts and D. J. Fleetwood, Birmingham—Hydraulic presses

25th September, 1868.

2940 J. Baggs, High Holborn—White lead
2941 J. Torbitt, Belfast—Preserving potatoes
2942 C. E. Brooman, Fleet Street—Breech-loading fire-arms.—A com.
2943 J. L. R. Steckel, Lincoln's Inn—Wind musical instruments
2944 J. Wright and W. H. Williams, Birmingham—Gas burners
2945 P. Kean, Glasgow—Dyeing textile fabrics
2946 C. Scriven and W. Holdsworth, Leeds—Boring machinery
2947 W. E. Newton, Chancery Lane—Adhesive stamps.—A com.
2948 G. Ritchie, Hounslow—Sun-proof fabrics
2949 W. J. Ledward, Middlesborough—Mechanical timekeepers
2950 R. Oxland, Plymouth, and J. Hocking, Redruth—Calcining ores
2951 E. Prevost, Notting Hill—Electro-magnets

26th September, 1868.

2952 P. J. E. Caron, Paris—Chains and ropes
2953 H. Davey, Westminster—Steam engines
2954 J. H. Johnson, Lincoln's Inn Fields—Railways.—A com.
2955 J. Sutcliffe, Manchester—Warping mills
2956 J. Ramsbottom, Crewe—Communicating in railway trains
2957 J. Heap, Ashton-under-Lyne—Lathes
2958 C. F. Whitworth and J. Pearson, Bradford, and W. Smith, Manchester—Railways
2959 P. Spence, Manchester—Illuminating gas
2960 J. Petrie, Rochdale—Washing wool
2961 J. Jones, Watling Street, and G. E. Wilkinson, City Road—Card board
2962 G. F. Morant, Trenchay—Artificial fuel
2963 V. Gallet, Sheffield—Cast steel
2964 H. Gibson, Musselburgh—Tobacco
2965 F. B. Dœring, Westminster—Machinery for boring rock
2966 J. Tangye, Birmingham, and J. N. Kitching, Dublin—Hydraulic machinery

GREAT MELBOURNE TELESCOPE.

Constructed by
THOMAS GRUBB, ESQ. F.R.S.

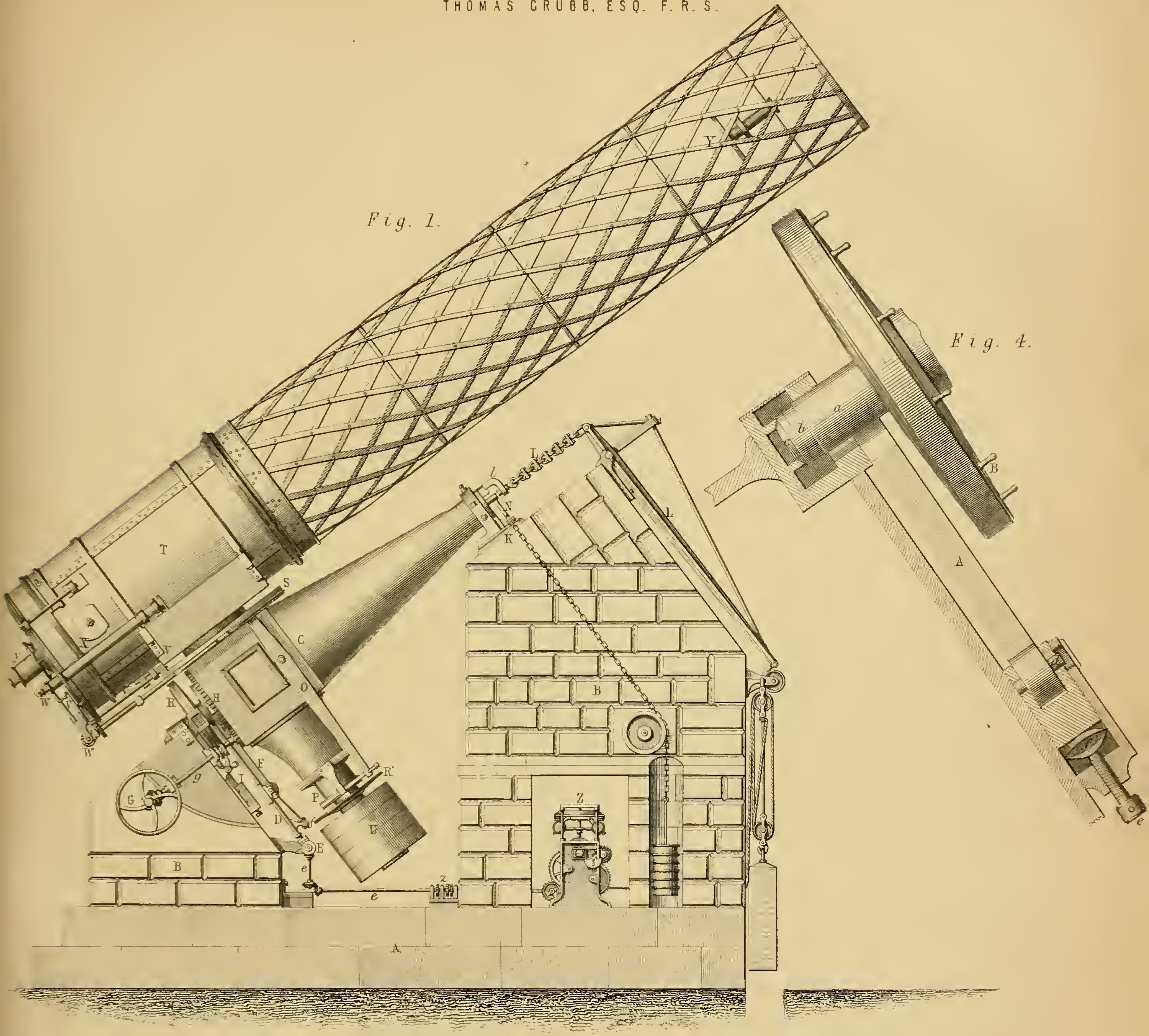


Fig. 1.
Fig. 4.

Fig. 2.

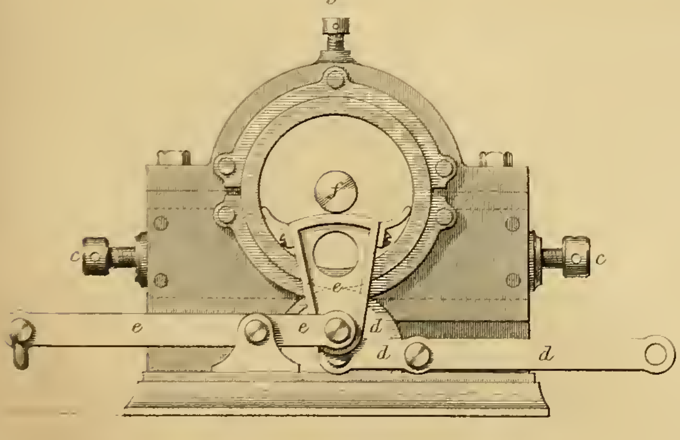
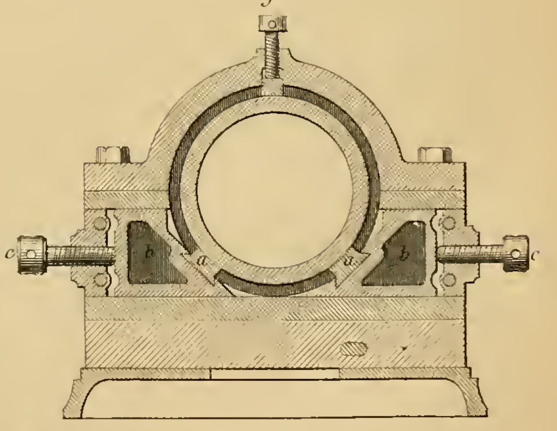


Fig. 3.



Patent Office 47 Lincolns Inn Fields London and 166 Buchanan St. Glasgow

THE HEATON STEEL-CONVERTING PROCESS.

THE Bessemer steel-making process marked in a very decided manner the opening of a new epoch in the history of steel manufacture; and that not alone by the originality and great intrinsic merits of the process itself, but as the forerunner of that succession of other new and more or less remarkable methods of steel-making, which from time to time have not ceased since then to appear, constantly infusing new life, energy, and extension into a manufacture which for ages previously had stood almost stock still, and was confined to the cementation process, or on a small scale, and little known elsewhere, to the Styrian method by means of the refinery.

It is matter of fact now beyond contradiction, however the more or less interested advocates of the Bessemer patent may endeavour to conceal or ignore it, that at first Mr. Bessemer's grand discovery was coldly looked upon by practical men, and regarded rather as a mere piece of laboratory fireworks, displayed by an ingenious but unpractical man, than as an invention likely to revolutionize the entire steel trade, as it has indeed already done. It is equally incontestable that Mr. Bessemer's method, as originally patented, was really incapable of producing with any certainty either wrought iron or steel, or, in fact, any uniformly workable product; and that its final success was due to the afterthought of employing spiegeleisen in the converter, a portion of the process as it is now carried on which is said to have belonged to another inventor.

Since then Mr. Bessemer has fenced up his patent by quite an army of other patents, no one of which, we believe, has even been attempted, or was probably ever intended, to be brought into actual operation. To one of the latest of these we shall have presently to recur.

We intend these remarks in anything but a hostile or depreciatory spirit towards Mr. Bessemer; his original patent may have been legally invalid, as, if we mistake not, Dr. Percy broadly hints it was, and the function performed by the spiegeleisen may have been a very happy accident that prevented a great discovery from lapsing back for possibly many years; but admitting to the full such legal difficulties to have existed, and to have been but by almost a hap-hazard avoided as to consequences, we fully and boldly maintain the greatness of Bessemer's merits, and the substantial justness of the splendid reward he is believed to have reaped from his discovery. The moral we wish to draw from his career is simply this—that as at first almost no one believed in the practical value of Bessemer's method, and yet all have come to recognize it now, so with every other great metallurgical discovery which proposes boldly to depart very far from beaten tracks and old-world ways, will it be found that the common herd of mankind are disbelievers in it at first, and ultimately are only convinced that new ways may yet be both true and good ways, by the stubborn testimony of facts addressing their senses.

Passing here without remark the large number of more important steel-making processes, which the celebrity of the Bessemer method chiefly, has called forth during the last twelve years or more, we come at once to the very latest of these, the Heaton steel-making process by the direct application of nitrate of soda, patented in 1866 (No. 798) and in 1867 (No. 1295), with disclaimers made in August of this year. New as this method is, it may be said to have to a great extent passed through the stage of disbelief and pooh-poohing, for it has been carried on upon a manufacturing scale for many months past by the inventor and his partners at Langley Mills, in the Erewash Valley, within a few miles of Nottingham and Derby, and we have good grounds for believing that both the iron and steel there made have realized good market prices, and their qualities been highly appreciated by those who have employed them.

The "make" both of iron and steel at these works, now, we understand, passed into new and opulent hands and about to be largely augmented, has so far, however, been small, arising entirely from financial difficulties in which the concern (like every other, nearly, that struggles with a new invention) was involved; and hence, as yet, these "makes" of Langley Mills have not acquired that *renommé* as fully or widely as we believe they merit.

In this we write with the support of the facts as to the Heaton process before us, which have been elicited by three competent professional gentlemen, who were engaged, not by Mr. Heaton or his partners, but by the present owners of the Heaton patent, to investigate and report upon it. We are in a position to state that the instructions given to these gentlemen were to subject the validity, practicability, and results of the Heaton process to rigid scrutiny, and to report their conclusions regardless of all but truth and facts. The reputation and character of the reporters—Dr. Miller of King's College, assayer to the mint; Mr. Mallet, M.I.C.E.; and Mr. Kirkaldy of the Grove Testing Works, Southwark—are a sufficient guarantee for the perfect truth of statement of the facts they have ascertained, and for the weight and importance of the conclusions they have drawn from these. Such of the metallurgic world as is disinterested will therefore understand what reliance may be placed upon the allegations of a contemporary journal (known to have the best reasons for championing the Bessemer process against all comers), which ventures to attribute "puffing" or inaccuracy to these reports, the character of whose authors is sufficient disproof of anything of the sort.

They have found that the Heaton process really does all that it was represented as being capable of; they state the facts; and they boldly draw such conclusions as these warrant, on the part of men well acquainted with both the science and existing practice of iron and steel making.

Bessemer's and Heaton's are, up to this time, the only two processes which produce steel from crude pig iron by what may be called direct and simple chemical action. All other processes, such as the Styrian (refinery), Wesphalian (puddling), Parry's, Uchatius', Martin's, and also the Siemens-Martin, though this in a less degree, depend not alone upon direct chemical reaction, but upon indirect methods, in which chemical action is constantly aided by mechanical manipulation; the latter involving great waste, often of material, always of fuel and labour.

The Bessemer process, as nearly all now know, depends for the production of the steel from the crude pig iron upon the powerful oxidizing action of streams of air driven through the liquid pig iron in the converting vessel, until the whole or nearly all the silicon, carbon, and, if present, metals of the earths and alkalies, are converted into oxidized compounds and driven off. Energetic as is the action of the oxygen of common air on cast iron at the extremely high temperature evolved in the converter, the process of "blowing through" has yet to be continued for many minutes, and until a very large percentage of iron is burnt or oxidized also, or thrown out mechanically by the violent action, before the whole of the silicon and carbon, &c., are got rid of, and the converted residue of metal is ready for the new measured dose of carbon being readded in the manganesiferous spiegeleisen.

But however long the blowing through in the Bessemer converter may be continued—and to this continuance there is a narrow limit set by the fact that, as soon as the last of the carbon is gone, the whole mass of liquid metal in the converter, no longer evolving heat of chemical decomposition, begins to be cooled by the further continuance of the currents of air, and were these long continued, would soon set into a solid, useless mass, to the destruction of the convertor itself—however long, we say, the blowing may be kept up, it is now long an admitted fact that, whatever phosphorus, or sulphur, or arsenic, or certain other rarer impurities, may have been in the crude pig iron, remain in it still, in very nearly, if not altogether, the same proportions that they were at first.

And, as the presence of more than a very small fractional percentage of phosphorus or of sulphur in iron, is fatal to its becoming converted into good steel, so it has resulted that the Bessemer process has proved incompetent to deal with any "makes" of crude iron which are naturally rich in phosphorus or in sulphur, and, in effect, this process is in its actual use confined at the present moment to perhaps a dozen makes of British iron, and to some of the purest known upon the Continent. Experimental efforts have not been wanting to try and remove this grand drawback to the universal employment of the Bessemer method, and it is not probable that the difficulty will be ever removed, nor that the very serious waste of the iron itself which takes place ever can be very much diminished.

The Heaton process also is a direct chemical reaction, but of a much more rapid and powerful character than the preceding, and giving rise, with greater promptitude and much less waste of iron, to more searching and complete results. It depends upon the intensely powerful oxidizing power of nascent oxygen, evolved from the nitric acid of nitrates of alkaline bases, when these are brought into contact with crude cast iron in a molten state. In this case, not only are the silicon, carbon, and earthy metals, if present, oxidized and removed, but a very large proportion, almost the whole, of the phosphorus and sulphur are also eliminated. The experiments and analyses already made prove this to be the fact, even when the crude pig iron employed was of Cleveland make, amongst which are some of the most phosphorus and sulphur charged irons known of British or indeed of any make. Facts are also already known to those engaged in the development of this method, which point distinctly to the means in every case of *absolutely* freeing the "converted" metal from every trace of phosphorus and of sulphur.

Upon the above facts, developed out to their practical consequences, depend the commercial value and future import of the Heaton process. It presents the means of making fine wrought iron and fine steel by the most simple, inexpensive, and direct processes from *any make* of pig iron, however bad or utterly useless for the Bessemer or for any other process; and it enables steel-making to become at once one of the vast staple trades of the Cleveland iron district, and of all the others hitherto shut out from like causes. It also enables such crude pig irons as are produced from the phosphuretted and sulphured brown hæmatites of Northamptonshire to be brought into immense and profitable use, and those almost inexhaustible deposits of that ore, not alone in England, but also in France and in the Rhine provinces of Prussia, and elsewhere, to become soon great seats of iron and of steel manufacture. To this we have to add, that the Heaton conversion process is all over in some five or six minutes, in less than one-fourth of the time of the Bessemer method; that whatever be the quantity operated upon, the time of conversion can remain the same; that little, if any, liquid iron is burnt, blown out, and destroyed; that the final amount of waste, between the ton of crude pig iron and its educt in steel, is less than with the Bessemer; and that the process is of the simplest and most manageable kind, and requires an outlay for plant greatly less than for an equal yield of Bessemer steel; that its quality appears to compete on at least equal terms with the best Bessemer steel; and that the process appears capable of yielding products quite as uniform as that of Bessemer does in its most practised hands.

If these be facts, and we have good reason for believing them to be so, then we think we are warranted in predicting that great as has been the extension and success of the Bessemer process, and largely as it is probable it may continue to be employed when the patent shall have expired, and owing to the large capitals already invested in Bessemer plant; yet, that Heaton's process is destined to a still greater future, and will be likely to absorb nearly every other process ultimately, wherever crude pig iron is the main material to be dealt with, for conversion either into first-class wrought iron or into steel of various qualities. With it, probably, the processes of Siemens-Martin, or of Siemens only, will divide the future steel-making of the world; these latter operating upon the stock, which will never be exhausted, of malleable or wrought iron as it drops out of use and is required to be replaced by steel. This seems, perhaps, a bold view as regards the future extension of steel in the world; but we hesitate not to express our belief that the days of wrought iron, as a universal structural material, are numbered, and that in the end it will be reserved for certain special uses for which its softness and other combined properties specially fit it, but that steel will become the leading material of construction for all our machines and all our structures.

As regards the future wide-spread extension of the Heaton process, it may be urged that it is dependent upon the supply of nitrate of soda; that this is, so far, obtained but from one and a distant locality; that monopoly may raise its price to a prohibitory rate; and that science, so far, does not point to any artificial method of supplying the salt, which jealousy or war or greed might withhold from us. This is to put the objections as strongly as they can be put, perhaps.

They really are devoid of any force. Inquiries made through competent channels indicate that practically the natural supply of crude nitrate of soda is unlimited; that it is found in nature scattered over so vast a superficial area of the rainless region of South America that any monopoly capable of affecting its price seriously, is impracticable; that when a greater demand than the present wants, confined as they have been to chemical manufactures and agriculture, shall have stimulated supply, tramways laid down from the plains to the coast will supersede pack-animal carriage, and in place of the price per ton rising, that it is likely materially to be reduced; and lastly, that even were the price of crude nitrate largely increased, it would not prevent the Heaton process from being still profitably and advantageously worked.

We have heard that Mr. Bessemer has himself visited Langley Mills, a considerable time ago, and having seen Mr. Heaton's process in operation, expressed his own high estimation of the method to the inventor personally. That such is Mr. Bessemer's own view does seem to be countenanced by the fact that, as late as the 30th June last (1868), Mr. Bessemer has himself filed the specification of a new patent for steel making by the use of nitrate of soda, and by the use of apparatus which, as described, and so far as it is capable of being worked, if it be so at all, which we greatly doubt, is palpably a repetition and infringement of Heaton's patent. The wording of the commencement of this specification is certainly most ambiguous and extraordinary, and whether so intended or not, is well calculated to mislead those who have not access to the specification of Mr. Bessemer's original patent of February, 1856, into the belief that in *that* patent he contemplated the use of nitrate of soda, or other nitrates.

The following is a *verbatim* extract from the commencement of the specification:—

"In the specification of a patent granted to me (Bessemer), and dated the 12th day of February, 1856, there is described the conversion of molten crude iron, or of remelted pig or finery iron, into steel or into malleable iron, without the use of fuel for reheating or continuing to heat the molten iron, such conversion being effected by forcing into and among the particles of a mass of molten iron, currents of air or gaseous matter containing or capable of evolving sufficient oxygen to keep up the combustion of the carbon contained in the iron till the conversion is accomplished. *This process is now well known as the 'Bessemer process;' one method of conducting it is to place beneath the molten iron a perforated case capable of bearing a high heat, and containing a solid matter, such as nitrate of soda*, which gives off oxygen on being heated. The heat of the molten iron causes the nitrate or other matter to liberate oxygen, which forces its way through the perforations in the case, and it issues into and amongst the particles of the molten iron, as when air is forced through the twyer pipes in the ordinary way of conducting the Bessemer process." He then goes on to describe his perforated plate as "a perforated fire tile, or a slab of refractory stone," and so forth. The specification, at length, may be seen in this journal for August last. All we have occasion to refer to it here for, is as proof that Mr. Bessemer himself is a witness, though we must say, in this instance, in a very unhandsome way, to the value of the nitrate converting process. For the rest, it is enough for us here to say, that as specified, the opening sentences above, as in italics by us, seem studiously obscure, and indeed scarcely grammatical, as if with the purpose of letting it be supposed that the process now well known as the Bessemer process, *ab initio*, contemplated the use of nitrate of soda, and not that its proposed use by Mr. Bessemer dates from the current year only; furthermore, that as specified, this patent could not be worked. We shall not delay, nor is this the place for pointing out why; but if it could by any possibility be worked, it would be an infringement of Heaton's patent.

The mere fact that nitrates at a high temperature would react upon the carbon in cast iron, and hence the probability that crude pig iron might by their use be "converted," is probably far from novel. It has long been known that nitre cast into a crucible of red-hot iron filings produces an explosion, from the energy of its oxidizing action both on the carbon and on the iron itself. We do not know that any serious attempt, however, was ever made upon a large scale to "convert" crude pig iron in the molten state by means of any nitrate; probably one reason being that most persons led by the mere light of chemical knowledge had, like ourselves some time ago, recoiled from any trial as assumed fraught with danger.

It appears, indeed, tolerably certain that whatever may have been attempted with other nitrates, the application of nitrate of soda to refining crude iron into wrought iron or into steel was really new at the date of Heaton's patents. Be that as it may, however, Mr. Heaton makes no claim to the mere use of nitrate of soda, but to the apparatus and method by which he employs it, and by which he avoids all danger, all difficulty or uncertainty, in its use.

This method and apparatus are of extreme simplicity, but perfect, sure, and sufficient, and these are in reality, as respects any invention, the *criteria* of the very highest merit. He claims in connection with his peculiar plant or apparatus, part of which consists of his converter, a perforated plate of *cast iron* covering the upper surface of the nitrate of soda, and it is of the essence of the functions of this plate that it shall be—1st, sufficiently difficultly fusible; 2nd, that nevertheless it shall *not* be infusible (like Mr. Bessemer's "perforated tile or slate of refractory stone"), but shall at the proper moment *melt and disappear*, giving *then* free access of the molten cast iron to the nitrate of soda; 3rd, that this plate shall be *corpus idem* with the molten iron to be converted, so that when it has melted, it shall become one with the charge of crude pig iron, and along with it be converted into steel.

We shall now in a few brief sentences describe the steps of the Heaton process itself, as at present conducted at Langley Mills, and the apparatus, not as already all existing there, but about being so extended.

The Heaton converter, fig. A, is nearly a cylindrical cupola, lined with 4½-inch firebrick, the shell of boiler plate, and surmounted by a plate-iron conical cap and narrower cylindrical flue, of a few feet in height. The cupola may be supposed cut in two horizontally at about one diameter and a half in height, and the bottom part rendered movable and capable of being withdrawn on wheels, without disturbance to the supports, &c., of the remaining upper portions of the converter. Ready means of temporary attachment by clamps and cotters are provided to connect the two parts, which thus so far present a close resemblance to the *Calebasse* cupola still in use in Belgium, and described a year or two back in our pages in one of the articles on the Practice of Ironfounding. At one side of the cylindric fixed part of the converter, a sort of hopper, with a loosely-hinged iron-plate cover, is provided, which communicates with the cavity within.

Fig. A.

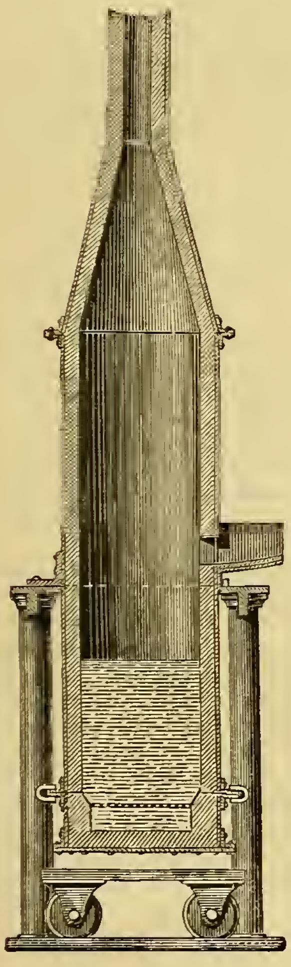


Fig. 4. Fig. 5. Fig. 3. Fig. 6

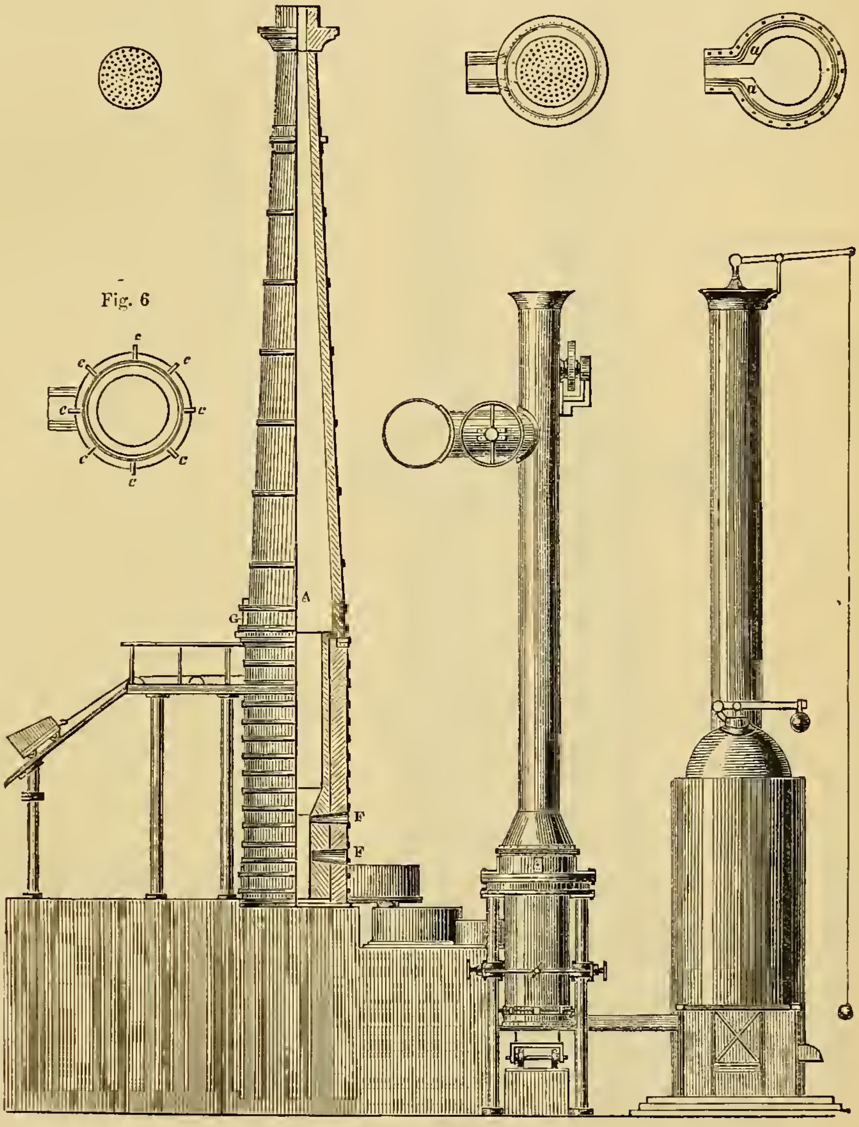
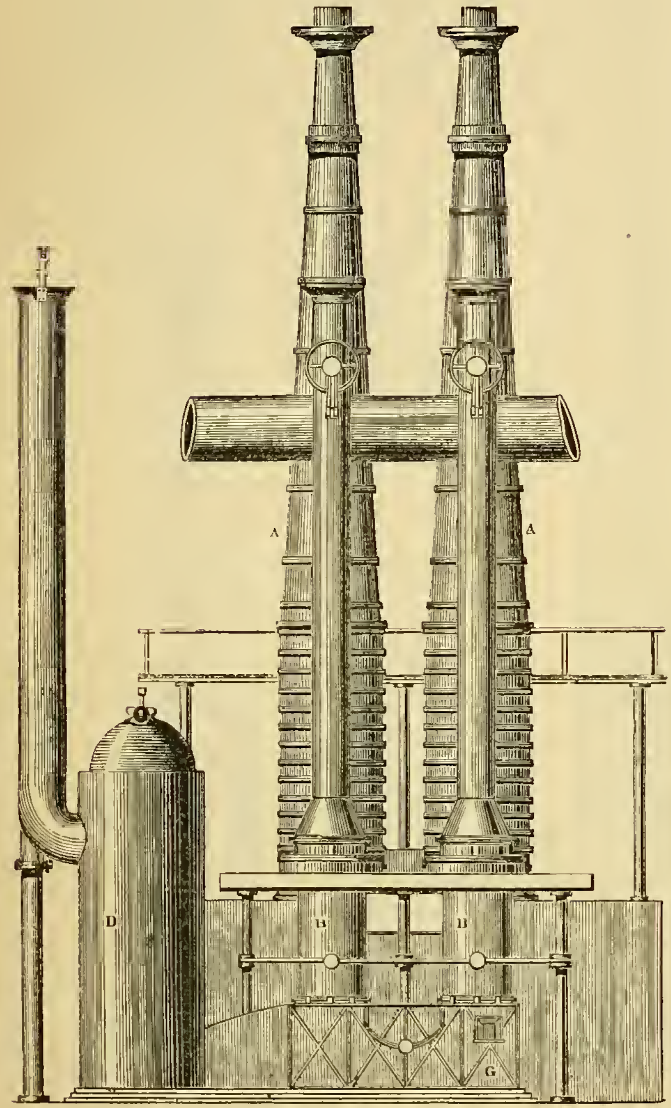


Fig. 1.

The lower part, or "converting pot," has a cylindrical cavity with a flat bottom, and with the sides near the top edge sloping inwards to a cone all round. The cavity, up to the level of the lower edge of this cone, is prepared to just hold the bulk of crude nitrate of soda required for the volume of liquid iron to be operated on, and for the latter when converted; the proportion of nitrate as at present employed by the patentee being 2 cwts. to the ton of liquid iron, or 10 per cent.—a proportion, we may remark, which both the metallurgists who have been engaged in examining into this process by the present owners of the patent are of opinion is a good deal in excess of what is needed, when the conditions for the most favourable reaction shall be more completely and scientifically understood. The "converting pot" is lined with firebrick and refractory clay. When the crude nitrate is filled in and levelled up to, or a trifle beyond, the narrow part of the conical lining, the cast-iron perforated plate is simply laid upon its levelled surface, and worked round a little until its edges bed firmly into and upon the clay lining. In this state the converting pot is rolled in under the upper part of the converter, clamped up to it, and the whole is now ready for work.

The charge of crude cast iron is melted with coke in an ordinary cupola; at present it is tapped out into a crane ladle. This is swung round by the crane, and the contents at once emptied into the opened hopper of the converter. The molten iron falls upon the cold cast-iron plate; its lowermost stratum is for the moment chilled and nearly consolidated by the heat withdrawn by contact, and for some minutes there is no perceptible action. In this state a vertical section of the charged and filled converter will be represented by fig. 1. Soon, however, the lower stratum recovers its liquidity, and begins to penetrate below the now more than red-hot and softened, perforated, cast-iron plate, and reaction commences, evidenced by the appearance of white and gray vapours at the top of the converter funnel. The nitrate has, no doubt, by this time got much impacted and partly fused at its upper strata. The reaction producing a large accession of heat at the plane of contact of the molten iron and of nitrate, the plate melts and disappears. A burst of brilliant yellow flame at the top of the converter funnel indicates that the reaction is then at its height. This lasts steadily for some few minutes (three to five usually, with 12 or 15 cwts. charges), and then rapidly subsides. The conversion is now complete. The bottom of the converter or "converting pot" is now detached and rolled away, and the converter is ready for another bottom and for another charge.

Fig. 2.



When we examine the converting pot withdrawn, we find its surface covered to the depth of an inch or two with a dark, blebby slag, through which brilliant jets of yellow sodium-coloured flame from escaping gases are constantly spurting. This slag consists chiefly of the soda of the nitrate, combined with silica and clayey matters derived from the lining of the converter, and involving some "shots" of metallic iron or steel, and some little silicate of iron, &c. Beneath this is the converted metal, which the patentee calls "crude steel." It forms a white-hot, *boursouflée*, and tolerably liquid mass, not sufficiently fluid upon the small scale of the 12 cwt. converters to readily be run or *tapped* out of the converting pot, but quite readily capable of that with a larger converter, and therefore larger mass of material.

The converting pot is upset upon the iron-plated floor, some water is aspersed to bring the mass to its frangible state at a dull red heat, and it is then broken up into lumps of a convenient size, to be brought, after receiving a little renewal of heat, under the "shingling hammers," and patted into "cakes of crude steel," as denominated by the patentee. It is purely a matter of "metallurgical taste" whether these are to be called crude steel or crude iron. The material is in reality a form of steely malleable iron, or mild malleable steel, whichever we choose to call it. It will not harden in water as perfectly as complete steel; it always, probably, where the process is rightly conducted, contains more combined carbon than usually belongs to wrought iron. It is, however, metal of the purest and finest quality, and from which, by two different methods of treatment, either very strong, but soft, tough, and malleable wrought iron may be made, or fine cast steel.

For the first the "cakes of crude steel" are piled, heated in a common balling furnace, and at once rolled out into "steel iron" bars or plates, or rails, &c.; and so fine is the material that but little difference is produced, except that of increased fibre, by cutting up, piling, and balling these bars and rolling a second time.

Then, for the cast-steel manufacture, these "cakes of crude steel" are broken or cut up, melted in 60 or 80 lb. clay crucibles, with about 2 or 3 lbs. per 100 lbs. of spiegeleisen, or its equivalent of oxide of manganese, and some charcoal, poured out into ingots of iron, *i.e.*, into the usual *ingot moulds of iron*, which a hostile contemporary affects to misunderstand—a tolerable proof of how hard-pushed he is for a cavil. These ingots of cast steel are then tilted into bars, and are cast-steel bars fit for market, or for any use to which excellent steel is suitable.

There is the whole process through its bifurcate train, up to wrought iron as good and stronger than Low Moor or Bowling, on the one side, and to cast steel as good as any other process can produce, upon the other.

Our illustrations, figs. 1 to 7, represent the plant, as the patentee, Mr. Heaton, at present advises its construction, and as proposed for the steel plant at the Langley Mill Steel and Iron Works, to a scale of one-eighth of an inch to a foot.

Fig 1 is a side view of the apparatus, showing also a vertical section of one-half of the cupola. Fig. 2 is a front view; and the same letters refer to the same parts in both views. Figs. 3, 4, 5, and 6, show different parts of the apparatus in plan. A, A, are cupola furnaces, in which the metal is melted. F, F, in fig. 1, are the tuyeres; G, the hole through which the cupola is charged with metal and coke from a platform with an inclined tramway leading to it. B, B, are the converters into which the melted metal is run direct from the cupolas, and from which the melted crude steel is run into the reverberatory furnace, C. D is a steam-boiler, heated with the waste heat from the reverberatory furnace. Fig. 3 is a horizontal section of the movable bottom of a converter, showing the fire-brick lining, *a a a*. When charged, the converter pot is filled with nitrate of soda. Fig. 4 shows a perforated metal plate, which is placed upon the nitrate of soda. Fig. 5 is a horizontal section of a converter, showing the perforated plate in position. Fig. 6 is a sectional plan of a converter, showing the cramps, *c*, *c*, &c., for holding the converter pot up to the cylinder of the converter whilst the converting process is going on: these cramps are shown also in figs. 1 and 2.

As given by the patentee, and we have no doubt correctly, the cost per ton of converting crude pig iron into "crude steel," exclusive of the cost of the pig, but allowing for the waste upon it at the ratio of 60*s.* per ton, is £2 4*s.* per ton, or £2 15*s.* in crude steel cakes; the cost of making into "steel iron" bars, *from the pig iron*, is £3 10*s.* per ton of finished bars, and the cost of making into tilted cast steel bars, from the pig iron, is £12 15*s.* per ton. We have seen the invoices of cast-steel bars of this sort, sold from Langley Mills, at prices equal to those now current at Sheffield for well reputed cast steel made by cementation.

In his preliminary report to the owners of the Heaton patent, Mr. Mallet says:—

"Dr. Miller has proved incontrovertibly that the Heaton process does eliminate from the crude pig iron almost the whole of the phosphorus and sulphur, the trace remaining being unobjectionable in the wrought iron and steel produced, even when these have been made from the pig irons known to be the richest in these injurious constituents of any make in Great Britain.

"The wrought iron made in my presence from Cleveland and Northampton pigs, and tested for tensile resistance also before me, bore a rupturing strain of 23 tons per square inch, and an elongation of nearly one-fourth of the original unit in length. It is therefore iron of great strength and toughness, and yet probably by no means the very best that this process is capable of producing hereafter. It possesses those qualities which best fit iron for artillery, armour plates, and iron ships or boilers.

"The tilted cast steel, also made in my presence from the very same pig irons as the above, bore a tensile strain at rupture of above 42 tons per square inch, with an elongation exceeding one-twelfth of the unit of length. It is, therefore, a remarkably tough and fine quality of steel, well suited for rails, shipbuilding, and all other structural uses. In a word, steel suited for any purpose known to the arts, can be produced by this system from very inferior brands of pig iron, from such as by no other known process could serviceable steel be made at all."

And as regards the qualities of the products, he states in a subsequent report:—

"The experiments recorded in tabular reports, A 5th August, B 26th August, C 19th September, and D 22nd September, all 1868, by Mr. Kirkaldy, with respect to the ultimate resistance to rupture by tension, and to the final elongation at rupture, of samples of 'steel iron,' and of 'cast steel' made by Heaton's patent process, show great uniformity as to the strength and toughness of the several classes of material tested, and present, when discussed, the following average results:—

	Rupturing Strain, in tons per square inch.	Extension at Rupture, in per cent. of original length.
Heaton's patent steel iron, . .	22·72 tons. ..	21·05 per cent.
Heaton's patent cast steel, . .	41·73 " ...	7·20 "

"These 'steel irons' and 'cast steels,' manufactured both by rolling and by hammering, having been converted from various makes of crude iron, from various and distant iron districts in Great Britain.

"As regards the 'steel irons,' the above averages compare most favourably with the very best, strongest, and toughest wrought irons; and as respects the 'cast steels,' show properties which rank them amongst the very best in the market produced by any process whatsoever.

"The 'steel iron' comes nearest in its properties to the Low Moor and the Bowling irons, the high values of which are universally known. The cast steel closely approximates in strength and toughness to that supplied to commerce by the largest and best-known works which are now producing Bessemer steel, such being the steel best adapted for rails, machine 'uses,' boiler-plates, ships, bridges, buildings, &c.

"I should deem the market value of Heaton's patent 'steel iron' and of his cast steel co-ordinate with those of the above highly reputed wrought irons and cast steels."

But that there may be no mistake as to this, we shall subjoin *in extenso* the tabulated report of Mr. Kirkaldy, of the results of his experiments upon the iron and steel made in presence of Dr. Miller and of Mr. Mallet, from Cleveland and Northamptonshire pig irons. These experimental results have not been previously published. Although only to be viewed as provisional, *i.e.*, made upon the identical products of the crude pigs converted in presence of the above gentlemen, and representing by no means *pet* results, nor such as are not likely to be hereafter greatly improved upon, they are sufficient to set at rest in any candid and unbiassed mind the importance of this process and the real value of its results. It is quite in vain for paid or interested opponents to carp at the results, or to make pretence of objection by juggling with analytical decimals picked out of Doctor this or that's "Metallurgy." There are the facts. Any one that wishes, with leave of the owners, can see the process put through at Langley Mills. Any one can see the results at their offices at Great George Street, Westminster, or at Mr. Kirkaldy's—seeing and handling is believing here, against any amount of talk or trash in or out of type. Mr. Kirkaldy's name is an abundant guarantee for accuracy and truth; established now for some years at his testing works in Southwark, and exposed to many difficulties, and to the temptations and to the necessity of reserve and denial incidental to his position as, in fact, a self-constituted public officer, he has won for himself golden opinions, and the most unlimited confidence of all engineers and manufacturers who know him; his name at foot of these experiments is therefore their sufficient authentication.

REPORTS OF MR. DAVID KIRKALDY.

CERTIFICATE OF IDENTIFICATION.

Cleveland and Stanton Iron.

I CERTIFY that certain round rolled bars of Heaton's patent steel iron, marked and numbered, and also certain bars of rolled cast steel, and square bars of tilted cast steel, also marked and numbered, were made on the 10th day of July, 1868, at Langley Mills Steelworks, by Mr. Heaton's patent processes, in my presence, and in that of Dr. Miller, vice-president Royal Society, and assayer to the Royal Mint (except in so far as that Dr. Miller, through illness, was unable to wait for the "pouring" and tilting, &c., of the cast steel); that the whole were made from a mixture of equal weights of Claylane, No. 4 (Cleveland's) pig iron, and of Stanton (BBB pig) Northamptonshire iron, treated in Heaton's patent converter; and that the above bars of steel iron and of cast steel were forwarded thence, in cases under my seal, to Mr. Kirkaldy's Testing Works, London. That I there identified the said bars when taken out of the cases in my presence, and that certain of those bars were tested before me, as to breaking strain and amount of elongation, by Mr. Kirkaldy, and that the results of such testings are those referred to in my "Preliminary Report," dated 12th September, 1868, addressed to the proprietors of Heaton's patents, and printed by them.

(Signed) ROBERT MALLET, C.E., F.R.S.

2nd October, 1868.

The testings above referred to are comprised in my Report A.

(Signed) DAVID KIRKALDY.

CERTIFICATES OF IDENTIFICATION OF MESSRS. HEATON AND GOULDER.

No. 1.

Cleveland and Stanton Iron.

LANGLEY MILL, NEAR NOTTINGHAM.

WE certify that the six square and five round bars of Heaton's patent steel iron, cross-piled and shingled into a bloom, and rolled, sent to Mr. Kirkaldy on the 22nd day of August ult., were made from a mixture of Middlesbro' and Stanton pig iron. The proportion of weight is 7 to 6.

(Signed) JOHN HEATON, *Engineer to the Works.*
" GEORGE GOULDER, *Works Manager.*

My testings of the above are given in Report B.

(Signed) DAVID KIRKALDY.

No. 2.

Scottish Iron.

LANGLEY MILL, 17th September, 1868.

WE certify that the four samples of steel, marked 1, 1, and 2, 2, and four samples steel iron, marked ◇1, ◇1, and ◇2, ◇2, and also four round bars of steel iron sent to Mr Kirkaldy, The Grove, Southwark Street, London, on the 17th day of September, 1868, were made from 13 cwts. of Glengarnock pig, No. 2.

JOHN HEATON, *Engineer to the Works.*
GEO. GOULDER, *Works Manager.*

My testings of the above are given in Report C.

(Signed) DAVID KIRKALDY.

No. 3.

Workington and Stanton Iron.

LANGLEY MILL, September 21, 1868.

WE certify that the ten bars of iron, marked 1, 1, 2, 2, 3, 3, 5, 5, 6, 6, and three bars of cast steel, marked "Langley Mill cast steel, 2, 3, 4," sent to Mr. Kirkaldy, The Grove, Southwark Street, London, on the 21st day of September, 1868, were made from 7 cwts. of Workington pig, No. 1, and 6 cwts. of Stanton forge pig, No. 4, mixed in cupola in the usual way.

JOHN HEATON, *Engineer to the Works.*
GEO. GOULDER, *Works Manager.*

My testings of the above are given in Report D.

(Signed) DAVID KIRKALDY.

REPORT A.—RESULTS OF EXPERIMENTS

TO ASCERTAIN THE TENSILE STRENGTH, &C., OF FIVE BARS OF CAST STEEL, TILTED, AND FIVE BARS STEEL IRON, ROLLED, RECEIVED FROM LANGLEY MILL STEEL AND IRON WORKS, *5th August*, 1868.

Test No.	Description, Stamped.			Original		Ultimate Stress.				Fractured.					Extension in ten Inches.			Appearance of Fracture.
				Size.	Area.	Total.	Per Square Inch of Original Area.			Size.	Area.	Difference. Area.	Difference. Per cent.		Inch.	Per cent.		
C	Cast Steel, Hammered.					Lbs.	Lbs.	Lbs.	Tons.									
1082	“4”	Taken out of Case which was Sealed up.	¾	·74 × ·73	·540	57,567	106,602	95,414	42·6	·69 × ·68	·469	·071	13·1	9 3	1·37	13·7	7·7	Granular.
1076	“5”		1	·98 × ·96	·941	98,480	104,654			·91 × ·89	·810	·131	13·9		1·12	11·2		“
1075	“4”		1	·97 × ·96	·931	86,210	92,599			·92 × ·91	·837	·094	10·1		0 56	5·6		“
1084	“6”		¾	·72 × ·74	·533	49,195	92,298			·70 × ·72	·504	·029	5·4		0 49	4 9		“
1077	“6”		1	·97 × ·99	·960	77,680	80,916			·95 × ·97	·921	·039	4·1		0·33	3·3		“
	Steel Iron, Rolled.			Diameter.														
1090	“5 ×”	Taken from Case which was Unsealed.	1	·96	·724	37,410	51,671	51,468	23·0	·71	·396	·328	45·3	44·1	2·55	25·5	25·2	Fibrous (peculiar)
1092	“7 ×”		1	·95	·709	36,610	51,636			·72	·407	·302	42·6		2·36	23·6		“
1089	“4 ×”		1	·96	·724	37,305	51,527			·71	·396	·328	45·3		2·54	25·4		“
1088	“3 ×”		1	·96	·724	37,160	51,326			·71	·396	·328	45·3		2 69	26·9		“
1091	“6 ×”		1	·96	·724	37,055	51,181			·73	·418	·306	42·2		2·45	24·5		“

7th September, 1868.

REPORT B.—RESULTS OF EXPERIMENTS

TO ASCERTAIN THE TENSILE STRENGTH, &C., OF ELEVEN PIECES OF STEEL IRON. ROLLED, RECEIVED FROM LANGLEY MILL STEEL AND IRON WORKS, *26th August*. 1868.

Test No.	Description.	Original		Ultimate Stress.				Fractured.					Extension.			Appearance of Fracture.
		Size.	Area.	Total.	Per Square Inch of Original Area.			Size.	Area.	Difference. Area.	Difference. Per cent.		Inch.	Per cent.		
C	Steel Iron, Rolled.			Lbs.	Lbs.	Lbs.	Tons.									
1059	1¼ Square.	1 23 × 1·22	1·500	70,125	46,750	49,371	22 0	·93 × ·92	·856	·644	42·9	42·9	2·87	28·7	26·7	Fibrous (peculiar).
1060	1⅛ “	1·11 × 1·10	1·221	58,155	47,629			·83 × ·82	·681	·540	44·2		2·86	28·6		“
1061	1 “	0 98 × 0·98	0·960	45,310	47,198			·72 × ·72	·518	·442	46 0		2·75	27·5		“
1062	⅞ “	0·87 × 0·86	0·748	35,778	47,831			·67 × ·66	·442	·306	40·9		2·79	27·9		“
1063	¾ “	0·75 × 0·75	0·562	28,820	51,281			·55 × ·55	·302	·260	46·2		2·61	26 1		“
1064	⅝ “	0·63 × 0·63	0·397	22,055	55,534			·50 × ·50	·250	·147	37 0		2·16	21 6		“
		Diameter.						Diameter.								
1065	1⅛ Round.	1·13	1·003	50,385	50,234	51,642	23·0	·82	·528	·475	47·3	44·6	2·57	25·7	25·3	“
1066	1 “	0·98	0·754	38,320	50,822			·70	·385	·369	48·9		2·72	27·2		“
1067	⅞ “	0·85	0·567	29,968	52,853			·66	·342	·225	39·7		2·46	24·6		“
1068	¾ “	0·73	0·418	21,630	51,746			·54	·229	·189	45·2		2·55	25·5		“
1069	⅝ “	0 63	0 311	16,345	52,556			·48	·181	·130	41·8		2·36	23·6		“
						50,506	22·5					4·38			26·0	

9th September, 1868.

REPORT C.—RESULTS OF EXPERIMENTS

TO ASCERTAIN THE TENSILE STRENGTH, &C., OF FOUR PIECES OF CAST STEEL, AND EIGHT PIECES OF STEEL IRON, RECEIVED FROM LANGLEY MILL STEEL AND IRON WORKS, *19th September*, 1868.

Test No.	Description, Stamped.	Original.		Ultimate Stress.				Fractured.					Extension.			Appearance of Fracture.
		Size.	Area.	Total.	Per Square Inch of Original Area.			Size.	Area.	Difference. Area.	Difference. Per cent.		Inch.	Per cent.		
C	Cast Steel, Hammered.				Lbs.	Lbs.	Tons.									
1141	“2”	0·55 × 0·55	0·302	32,652	108,117	99,481	44·4	·47 × ·47	·221	·081	26·8	16·9	1·19	11·9	8·5	{55 per cent Silky. {45 p. ct. Granular
1140	“1”	0 55 × 0·55	0·302	27,435	90,844			·53 × ·53	·281	·021	6·9		0·50	5·0		Granular (peculiar).
1139	“2”	1·01 × 1·01	1·020	88,630	868,92	84,877	37·8	·99 × ·99	·980	·040	3·9	3·9	0·40	4·0	4·1	“
1138	“1”	1·01 × 1·01	1·020	84,520	82,862			·99 × ·99	·980	·040	3·9		0·42	4·2		“
					Mean	92.179	41·1					10·4			6·3	
	Steel Iron, Hammered															
1144	“◇1”	0·60 × 0 58	0·348	18,160	52,184	51,620	23·0	·48 × ·46	·221	·127	36·5	23·1	1·39	13·9	11·3	Fibrous.
1145	“◇1”	0·61 × 0·59	0·360	18,380	51,055			·58 × ·56	·325	·035	9·7		0·86	8 6		Crystalline.
1142	“◇2”	0·98 × 1·01	0·990	46,685	47,152	46,596	20·8	79 × ·82	·648	·342	34·5	30·2	1·72	17·2	14·4	Fibrous.
1143	“◇2”	1·02 × 1·00	1·020	46,960	46,040			·90 × ·84	·756	·264	25·9		1·16	11·6		“ 12p. ct. Crystalline.
	Rolled.	Diameter.														
1148	“▪▪”	0·99	0·770	40,570	52,689	51,877	23·1	·80	·502	·268	34·8	39·1	2·16	21·6	24·4	“
1149	“▪▪”	0 99	0·770	40,340	52,390			·77	·466	·304	39·5		2·45	24·5		“
1147	“▪”	0·99	0 770	39,730	51,597			·77	·466	·304	39·5		2·37	23·7		“
1146	“▪”	0·99	0·770	39,140	50,8[illegible]1			·75	·442	·328	42·6		2·77	27·7		“
					Mean	50,031	22·3					30·8			16·7	

REPORT D.—RESULTS OF EXPERIMENTS

TO ASCERTAIN THE TENSILE STRENGTH, &c., OF THREE PIECES OF CAST STEEL, AND TEN PIECES OF STEEL IRON, RECEIVED FROM LANGLEY MILL STEEL AND IRON WORKS, 22*nd September*, 1868.

Test No.	Description, Stamped.	Original.		Ultimate Stress.				Fractured.					Extension.			Appearance of Fracture.
		Size.	Area.	Total.	Per Square inch of Original Area.			Size.	Area.	Difference. Area.	Difference. Per cent.		Inch.	Per cent.		
C	Langley Mill Cast Steel, Hammered.				Lbs.	Lbs.										
1166	"3"	0·76×0·74	0·562	55,385	98,550	92,961	41·5	·71×·71	·504	·058	10·3	13·9	1·01	10·1	7·6	Granular.
1167	"4"	1·00×0·99	0·990	91,720	92,646			·99×·98	·970	·020	2·0		0·24	2·4		".
1165	"2"	0·56×0·57	0·319	27,972	87,686			·47×·48	·225	·094	29·4		1·03	10·3		25 per cent ditto 75 per cent. Silky
	Steel Iron, Hammered.															
1169	"1"	0·51×0·51	0·260	14,745	56,711	52,711	23·5	·36×·36	·129	·131	50·4	30·6	1·83	18·3	16·3	Fibrous. (peculiar).
1168	"1"	0·56×0·56	0·313	17,445	55,735			·47×·47	·221	·092	29·4		1·46	14·6		"
1175	"3"	1·00×1·01	1·010	56,015	55,460			·80×·81	·648	·362	35·8		1·93	19·3		"
1174	"3"	1·02×1·00	1·020	56,310	55,206			·83×·81	·672	·348	34·1		2·06	20·6		"
1171	"2"	0·78×0·80	0·624	33,678	53,971			·70×·72	·504	·120	19·2		1·15	11·5		"
1170	"2"	0·78×0·78	0·608	32,342	53,194			·70×·70	·490	·118	19·4		1·04	10·4		"
1176	"6"	0·59×0·60	0·354	17,470	49,350			·53×·54	·286	·068	19·2		1·13	11·3		"
1177	"6"	0·56×0·60	0·336	16,568	49,309			·46×·50	·230	·106	31·5		1·80	18·0		"
1173	"5"	0·79×0·77	0·608	30,020	49,375			·65×·63	·409	·199	32·7		1·92	19·2		"
1172	"5"	0·78×0·77	0·600	29,280	48,800			·63×·62	·390	·210	35·0		2·01	20·1		"

To the Proprietors of "Heaton's Iron and Steel Patents."
20 Great George Street, Westminster, S.W.

Testing and Experimenting Works, The Grove, Southwark Street, S.E., 23*rd September*, 1868.

DAVID KIRKALDY.

Our metallurgical readers will now be anxious to know what are the chemical reactions that have occurred in the process, and what has become of the phosphorus and sulphur that have been eliminated from the crude iron.

The following extracts from Dr. Miller's report will satisfy generally these inquirers. It is to be borne in mind however, that these analytical results refer only to the iron and steel converted in the presence of Professor Miller and Mr. Mallet. The results of more general experiments yet remain to be completed and published, which alone must be viewed as representing a complete generalization of results, an average, in fact, of what the Heaton process performs.

The results here given, though not on that broad base of such a generalization, yet must not be looked upon as isolated, or picked, or above average results; on the contrary, there is every reason to believe that they are below the true average.

No analysis as to carbon has yet been published by Dr. Miller, of the tilted *cast steel* made by Heaton's process. This is sufficient explanation as to the silly blunder made by the writer in a hostile journal, that the Heaton *cast steel* contains 0·292 per cent. of phosphorus. It is the steel iron or malleable iron to which that applies, and which that engineering oracle has mistaken for cast steel.

Dr. Miller says—

"I have made an examination of the following samples only:—

No. 4.—Crude cupola pig.
No. 7.—Hammered crude steel, or cakes.
No. 8.—Rolled steel and iron.
No. 5—Slag from the converter.

I shall first give the results of my analysis of the three samples of metal:—

	Cupola Pig (4).	Crude Steel (7).	Steel Iron (8).
Carbon,	2·830	1·800	0·993
Silicon, with a little titanium,	2·950	0·266	0·149
Sulphur,	0·113	0·018	traces
Phosphorus,	1·455	0·298	0·292
Arsenic,	0·041	0·039	0·024
Manganese,	0·318	0·090	0·088
Calcium,	—	0·319	0·310
Sodium,	—	0·144	traces
Iron (by difference),	92·293	97·026	98·144
	100·000	100·000	100·000

"It will be obvious from a comparison of these results that the reaction with the nitrate of soda has removed a large proportion of the carbon, silicon, and phosphorus, as well as most of the sulphur. The quantity of phosphorus (0·298 per cent.) retained by the sample of crude steel from the converter which I analyzed is obviously not such as to injure the quality, *i.e.*, of the steel iron (8) rolled from it.

"The steel iron (No. 8) was in our presence subjected to many severe tests. It was bent and hammered sharply round cold without cracking. It was forged and subjected to a similar trial, both at a cherry red and at a clear yellow heat, without cracking; it also welded satisfactorily.

"The removal of the silicon is also a marked result of the action of the nitrate.

"It is obvious that the practical point to be attended to, is to procure results which *shall be uniform*, so as to give steel of uniform quality when pig of similar composition is subjected to the process. The experiments of Mr. Kirkaldy on the tensile strength of various specimens, afford strong evidence that such uniformity is attainable.

"I have not thought it necessary to make a *complete* analysis of the slag, but have determined the quantity of sand, silica, phosphoric and sulphuric acid, as well as the amount of iron which it contains.

"Of 100 parts of the finely powdered slag, 11·9 were soluble in water. The following was the result of my analysis:—

Sand,	47·3
Silica, in combination,	6·1
Phosphoric acid,	6·8
Sulphuric acid,	1·1
Iron (a good deal of it as metal),	12·6
Soda and lime,	26·1
	100·0

"This result shows that a large proportion of phosphorus is extracted by the oxidizing influence of the nitrate, and that a certain amount of the iron is mechanically diffused through the slag.

"In conclusion, I have no hesitation in stating that Heaton's process is based upon correct chemical principles: the mode of attaining the result is both simple and rapid. The nitric acid of the nitrate in this operation imparts oxygen to the impurities always present in cast iron, converting them into compounds which combine with the sodium; and these are removed with the sodium in the slag. This action of the sodium is one of the peculiar features of the process, and gives it an advantage over the oxidizing methods in common use.

"(Signed) WM. ALLEN MILLER."

It is not to be understood from these general statements of Dr. Miller, that the whole of the phosphorus becomes combined with the slag. On the contrary, it seems highly probable that a portion is also volatilized in some form of combination—not impossibly with sodium.

Such is the Heaton steel process described, though at some length, too briefly for its importance and future prospects, which undoubtedly have an import of nothing less than national importance.—Ed.

ON THE DISPOSAL OF THE SEWAGE OF GLASGOW.

For many years past it has been but too evident that one of the public duties devolving more especially upon the present than on preceding generations, is to devise and carry out means for the efficient removal and utilization of the sewage emanating from the large towns and cities, in which are congregated such vast masses of our increasing population.

It must be obvious enough to any one who has paid attention to this most important branch of sanitary engineering—next in importance indeed, if not on a par, with the providing an abundant supply of pure water—that no universally applicable mode for the disposal and utilization of sewage can be laid down. There are special circumstances in each case which require to be met in devising the works for effecting the object under our consideration, such as the position or levels of the locality in which the sewerage works are to be carried out relatively to those of the surrounding country; the nature of the land and the crops grown upon it, as well as of the sewage itself—which varies so much, especially in manufacturing centres, that if used for agricultural purposes it might prove highly injurious at certain times. Besides questions of this order, several others arise depending greatly upon the habits of the population—the mode adopted for passing the excreta and other matters which go to contribute what is now understood by the term "sewage," whether by water-closets, dry closets, and so on, into the sewers, or whether, as in many European towns, the fœcal matter and urine be collected in cesspools, and withdrawn occasionally therefrom, not going into the sewers at all; again, there are involved all the circumstances growing out of the amount of water supply, and the climatic influence of rainfall.

But out of all the foregoing and sundry others to which we might allude, this great subject appears to divide itself initially into two main questions most difficult of settlement, viz., whether the liquid, and what are termed, though not strictly, "solid parts" of sewage, should pass away together into the sewers admixed; or, on the other hand, whether they should be separated before passing away, and the solid parts be prevented from going into the sewers at all. Means in abundance have been devised with the view of attaining both objects, indeed systems for effecting both are in operation with more or less success in various towns and cities of Europe, which we may hereafter have to notice.

Besides the mere mode of taking the sewage away from the centres of population, there is another equally serious consideration, viz., whether the sewage is to be utilized at all, or sent away into the sea as waste and refuse, as in the case so far of that proceeding from our vast metropolis.

Next in importance to London itself in this island, so far as population goes, is the city of Glasgow, which has long suffered from the want of sewerage works. Time upon time has it been mooted by succeeding lord-provosts and town councils, that the population and importance of the city had reached a pitch whereat the furtherance of this most important sanitary work—from the absence of which the health of the population was injured to such an extent as to have long since placed Glasgow with a death rate usually at the top of the list—could not longer be postponed.

But like all other public questions in this city—excepting perhaps the increase of local taxation, which appears always to be easily and quickly managed—the sewage question has up to the present time ended in talk, and from a recent official announcement it appears to be thus settled for some time to come. The *vox populi*, however, is an immense power in this country—in Scotland more especially, perhaps, than on the other side of the border—and the public are alive to the weight of the duty devolving upon them. Surely it is despicable that Glasgow, next in population to London itself, and third even in wealth, a centre of population known all over the world for her enterprise and public spirit, should have thus long rested tranquilly under the dallying do-nothingness of her municipal government—the direct result of all which has been to render it one great hive of human beings wallowing in the mire of pollution—consequent disease. The question cannot be permitted to rest any longer.

We proceed to consider the steps taken in the report of Messrs. Bateman and Bazalgette, the obtainment of which has been the last act but one on the part of the authorities in connection with the Glasgow sewage question. Glasgow, including Gorbals, lies on both banks of the Clyde. Its population is about 500,000 persons. Owing to the prevalance of the "flat" system of dwelling houses in Scotland, the area covered by the city is considerably smaller in proportion to the population than in English towns. On the north side of the river a belt of tolerably flat land skirts the banks right through the city, at the back of which it rapidly rises, the higher parts of the town attaining elevations of about 200 feet above the level of the sea. On the south side some low level ground occupies a narrow belt adjoining the river, from the southern margin of which the ground rises to an elevation of about 100 feet above sea level.

Several streams or burns, as the Camlachie, the Molendinar, St. Enoch's, and Pinkston burns, notorious for filth and the production of disease, at present empty themselves, together with the river Kelvin, which drains the new western portions of the city, into the Clyde at various points; these also cut up the sloping ground on the north side into a succession of ridges and valleys. On the south side no burn or stream of any importance occurs within the area occupied by buildings.

The area to be drained is chiefly of such contour as to enable a large portion of the sewage to be carried off by intercepting sewers, and without being lifted by pumping, whilst in other parts the level is so low that pumping would have to be resorted to.

In their report Messrs. Bateman and Bazalgette remark—"The Clyde passes from east to west through nearly the centre of the city, varies considerably in its volume, being probably not much above 100 cubic feet per second, or 50,000,000 gallons per day in drought, and 300 or 400 times that volume in flood. The harbour of Glasgow terminates at present about the centre of the city, and the river has been deepened by artificial means from a navigable depth of a few feet, which was all it possessed at the commencement of this century, to its present depth of about 24 feet at high water. The effect of this deepening and of the enlargement of the channel, all the way down to deep water at Greenock, while it has so improved the port that the receipts have increased from £300 or £400 at the commencement of the century, to £140,000 per annum at the present time, and has created a trade equal in tonnage to one-third of that which is carried on in Liverpool—has been to lessen the velocity of the downward progress of the stream, and by thus, as it were, impounding the sewage has retarded its passage out to sea."

In regard to the question pertaining to the rate at which sewage would flow down the harbour, Mr John F. Ure, C.E., formerly engineer to the Clyde Trustees, made in 1857 and 1858 a series of experiments with wooden floats, which showed that sewage which entered the river at Glasgow Bridge, situated about the centre of the city, took at least a week to reach Govan, a distance of only some 2·5 miles, in times when the natural volume of the river was small; that it would not reach the mouth of the Cart at Renfrew, a distance of six miles, in less than a fortnight; and to reach Dumbarton it would occupy more than a month. These facts may give some fair idea as to the stagnant and malarious state of the water lying in Glasgow harbour, into which the whole sewage of the city is passed.

Above Hutchesontown Bridge a weir extends across the river, and in so far prevents the sewage from passing up the stream beyond it. This, however, is now to be removed, and while it will, no doubt, have the effect of increasing the scour in the harbour and lower reaches of the river, especially during seasons of flood, it may at the same time probably permit some of the sewage to pass further upstream. Now the chief object, we believe, that has been held in view in removing the weir is to produce sufficient scour to keep the channel at its full depth and width, but it is clear that, during dry seasons when the volume of water would be small, if this is obtained, the passage of the sewage downstream would be retarded rather than facilitated.

In concluding the preliminary part of their report Messrs Bateman and Bazalgette remark—

"The city itself, on both sides of the river, possesses great facilities for good drainage, which have been carefully and judiciously taken advantage of, and the city may be considered therefore as thoroughly well drained. For the greater part, the sewers have short and rapid runs, and flow direct to the river. The extensive introduction of water closets, together with the refuse of many distilleries and chemical works, swell the volume of the sewage beyond that of most towns, and increase its offensiveness. Received into the river, it stagnates and putrifies in the harbour, poisoning the air, injuring the health of the residents, acting destructively on the sheathing of vessels in the harbour, annoying all travellers by steamboat, and no doubt injuring the trade of the port.

"This condition of things has of late become unbearable, and the question of how the evil is to be remedied and the sewage disposed of, is what we are called upon to consider.

"The population of the city, within the limits of water supply, according to the census of 1861, was 437,307. Its rate of progress during the ten years ending 1861 was 20 per cent. of increase upon the population of 1851, and during the previous 20 years the increase had been about 70,000 in each decennial period. The city, as before stated, is now estimated to contain 500,000 persons. The population of the immediate suburbs is included in these calculations, and the probable future increase for 20 years at least, must be taken into account in determining the size and direction of the sewers. The population may be expected in 20 years to number from 700,000 to 750,000.

"In considering also the area for which drainage works must be prepared, the circumstances of the towns within the basin of the Clyde, above and below Glasgow, must be duly regarded. With the exception of Rutherglen, which almost immediately adjoins Gorbals on the south of the river, and Pollokshaws, which lies but a short distance off on the same side, there is at present no town of importance in the basin of the Clyde, above the city, which it would be necessary or desirable to include in a drainage scheme for Glasgow. The only important towns are Hamilton, Airdrie, Coatbridge, and Lanark. Many small mining and other villages are scattered over the country, but in no case do they form great centres of population.

"In all cases there exist great facilities for disposing of their sewage upon neighbouring lands. If therefore at any time the sewage discharged from any of them be objectionable in bulk or quality, the towns should be required to dispose of it upon lands or otherwise in such a way as to prevent any pollution. At present the only town which has any regular system of sewerage is the town of Hamilton.

"With respect to the towns which lie below the city, Renfrew, Paisley, and Johnstone may probably with advantage be included in a scheme for Glasgow, but in any case, whether included or not, these towns, as well as all others in the basin of the Clyde discharging offensive matters, should be required to dispose of the sewage without permitting it to flow into the river, unless rendered unobjectionable by previous purification."

It certainly appears very short-sighted that in making a proposal for such gigantic sewerage works, these are to be designed with the view of providing only for the increase of population twenty years hence, or so.

We must reserve a fuller consideration of that part of Messrs. Bateman and Bazalgette's scheme for removing the sewage of the city until next month, merely here stating that they propose to intercept it from flowing into the harbour, using some portions for irrigating certain lands in the valley of the Clyde, whilst the bulk is to be carried away in a conduit and discharged over the sands on the Ayrshire coast, between Troon and Irvine. The conduit proposed is to be about 30 miles in length, in which there are no less than 18 miles of tunnel. We need not say, in concluding this first paper, that the proposal is looked upon with great disfavour here in Glasgow, and it is certain that, as now proposed, it will never be carried out.—V. D.

PREPARATION OF THALLIUM FROM THE RESIDUAL SOLUTIONS OF WHITE VITRIOL WORKS, AND THE LEAD OF THE LOWER HARTZ.

In the works of Hertzog-Julius, near Rammelsberg (Brunswick) there is found a mineral, which is rich in zinc and in lead (sulphides of these metals); after this has been roasted and afterwards lixiviated in water, it gives a solution of white vitriol (sulphate of zinc) of a density at 24° C. 1·441. This liquid, of which hundreds of tons may be had, is so rich in thallium, that according to Bunsen, this metal may be obtained from it in kilograms. The following analysis gives the composition of this liquid; it contains in 100 parts—

Sulphate of zinc,	21·740
" manganous protoxide,	8·230
" magnesia,	0·717
" potassium,	0·581
" cadmium,	0·536
" soda,	0·443
" protoxide of iron,	0·386
" copper,	0·285
" lime,	0·075
" aluminium,	0·060
" lead,	0·008
" lithium,	traces
Arsenious acid,	
Oxide of antimony,	
Phosphoric acid,	
Chloride of thallium,	0·050
Hydro-sulphuric acid.	0·119
Chlorhydric acid,	0·009
Water,	66·761
	100·000

The best way of extracting the thallium from the liquid, according to Bunsen, is to precipitate together the metals, copper, cadmium, and thallium, by plunging into it a piece of zinc. The metallic spongy mixture thus obtained is rapidly washed, at first with water, by placing it in a woollen bag; a little sulphuric acid is then added to the water, which dissolves the thallium and the cadmium, with release of hydrogen, but without attacking the copper. From the solution thus obtained the thallium is precipitated by iodide of potassium in the form of a fine yellow iodide, which is afterwards purified by washing and decantation; from the remaining liquid, the cadmium is precipitated in the metallic state by a plate of zinc. A cubic metre of this liquid gives in a few days 6·4 kilos. of this spongy precipitated metal, containing 4·2 kilos. of cadmium, 1·6 kilos. of copper, and 0·6 of thallium; 7·4 kilos of metallic zinc remaining dissolved. The solution of cadmium and thallium in the sulphuric acid give on the addition of 0·5 kilos. of iodide of potassium, 0·97 kilos. of iodide of thallium. The thallium may be precipitated from the solution in the sulphuric acid by means of chlorides, but the cadmium retains then a considerable part of the former metal. The thallium may be obtained directly and at once from the first liquid, by precipitation with iodide of potassium, provided that there has been first added a sufficient quantity of hyposulphite of soda to keep the copper in solution; but the application of this last method is opposed to the industrial object with which the liquid has been obtained, namely, the manufacture of sulphate of zinc.

Additional interest is given to the discovery of this new source of thallium, from the fact, as noticed in the last part but one of this Journal, that this metal proves in many respects a highly advantageous substitute for lead in the production of pastes for artificial gems, and probably will hereafter for fine flint glass for cutting.—Ed.

HARVIE'S LAMPS AND DIOPTRIC LENSES.

In lamps hitherto used for burning fixed oils it has been impossible to dispense with the employment of a chimney for conveying away the smoke and unburnt residue arising from an imperfect combustion; and in the lanterns for ships, railway signals, and other exposed lights, the necessary employment of a chimney rendered their construction such that in storms the light was frequently put out by the "down-draft" through the chimney. By a construction of lamp-burner and lantern designed by Mr John Harvie, of Glasgow, the use of the chimney is dispensed with, the whole, or nearly the whole of the oil being effectually consumed, and attended with the production of a much brighter and steadier light than has been hitherto obtained, besides admitting such an arrangement of the lantern that no "down-draft" takes place. We can speak of these lamps from personal examination, having had one of them (a ship's light) under our own control for some time. Besides this first step which Mr. Harvie has made, he has also effected a considerable economy in the cost of the dioptric lenses with which they are fitted. The dioptric lenses hitherto employed for first-class ship lights are constructed of the best flint glass, and finished in separate pieces (polyzonal) by grinding and polishing. The lenses now designed are pressed in accurately formed metallic moulds, and the result is that a dioptric lens with semi-circular ends is produced all in one piece, and although not quite so perfect as the ground and cut lenses, nevertheless there can be no question of their answering the end in view. The lenses which we have seen were made in Glasgow at the City Flint-glass Works. So important are the improvements which have now been made considered, that the matter was brought under the notice of the Institution of Engineers in Scotland by Mr. J. R. Napier, F.R.S., at their last meeting.

The wood-cuts and following description will render the improvements intelligible.

The top part of the air space surrounding the lamp is inclosed by a cap in the ordinary way, through which the flame escapes, and the entire lamp is inclosed in the lantern by a sliding door so as to form a separate chamber and to cut off access in that way with the atmosphere of the outside of the chamber. The upper part of the lantern is also formed double, with a conical cap inside and a hole in its centre, through which any smoke or unburnt gases given off by the combustion of the oil escape. The chimney of the lantern is formed so that in the case of a storm, when any air may blow down the top opening it cannot reach the flame, but is distributed by means of the case and escapes through side openings.

Fig. 1.

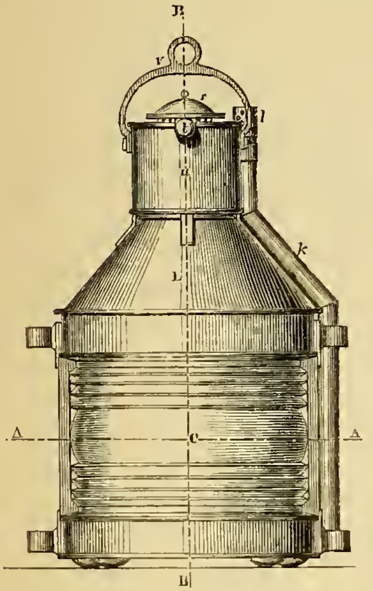
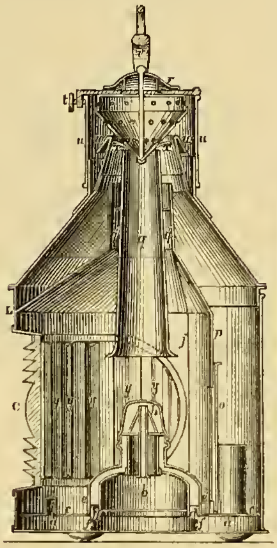


Fig. 3.



In addition to the formation of dioptric lenses with semicircular ends, prisms are placed in the interior of the lens at right angles to the ribs or bands constituting the dioptric lens proper.

Fig. 1 is a front elevation; fig. 2 a sectional plan on the line A–A, fig. 1; and fig. 3 is a section on the line B–B, fig. 1. The lantern, L, is provided with a double bottom, the space, *a*, between them forming an air chamber, from which air is supplied for combustion in the lamp, *b*; a circular opening is cut in the inner bottom, *c*, and round the upper side of it a rim, *d*, is formed, over which an outer casing, *e*, on the lamp, *b*, is placed, and the space, *a*, between the bottoms is inclosed by a perforated plate, *f*, through which the air is supplied to the annular space, *g*, through which it passes to the burner, *h*; small tubes, *i*, are also fitted in the inner bottom, *c*, through which air passes into the inner chamber, *j*, of the lantern. The air passes into the lantern by a tube, *k*, figs. 1 and 2, fitted with a perforated cap, *l*, and communicates with the outer chamber, *m*, by a tube, *l′*, whence it passes into the air chamber, *a*, by two tubes, *n*, *n*, placed one at each side of the lantern, as seen on fig. 2, or air may be admitted by tubes passing down the inside of the lantern, or through the bottom. Communication is obtained with the inner chamber, *j*, for the purpose of lighting and trimming the lamp, by a sliding door, *o*, which is fitted in the partition, *p*, and in which a small orifice or sight-hole filled with glass is formed, so that the light may be inspected without opening communication with the external atmosphere. The smoke or unconsumed gases pass up the duct, *q*, and the annular space, *q′*, and escape to the atmosphere by perforations formed in the conical cap, *r*, which is hinged to the outer casing at *s*, and is fastened by a screw, *t*, as shown at fig. 3. The top of the lantern is inclosed by a cylinder, *u*, to which the handle, *v*, is fixed, as shown on fig. 1; and to prevent gusts of wind passing down the duct during a storm the outer casing of the lantern is carried up inside of the cylinder, *u*, and turned over so as to form a bell-mouthed flanch, *w*, by which means the air is deflected, and passes out by an annular opening at the bottom of the cylinder, *u*. Such accidents are still further guarded against by forming a flanch, *x*, round the conical cap, *r*, as shown on fig. 3. The lantern is furnished with a dioptric lens, C, with semicircular ends, and formed in one piece, as shown. The exterior face of the lens is formed with prismoidal ribs of the usual form, and the illuminating power of the light is still further increased by forming prismoidal ribs, *y*, on the interior surface of the lens, as shown in figs. 2 and 3. Fig. 4 is a section of a lamp in which common oils, in contradistinction to paraffin oil, may be burnt; *a* is the vessel in which the oil is contained, and the air necessary for combustion is conveyed to the burner, *e*, through the tubes, *d*. An Argand burner may also be used as the illuminating apparatus in these lamps. These lamps, we should add, have been most severely tested during the recent gale which visited this island, and when their efficiency was fully proved. —V. D.

Fig. 2.

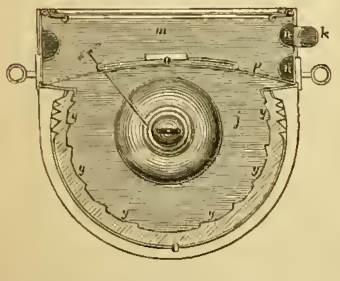
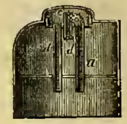


Fig. 4.



ANCIENT COINS AND METHODS OF COINING.

By Joseph Newton, Royal Mint.

(*Continued from page* 200.)

Although, as explained in a preceding chapter, the general mode of coining practised by the Romans in Britain, was that familiarly known as the "hammer and tongs" system, yet it is certain that moulds for casting money were not infrequently used. Of this we have the most conclusive evidence in the fact that very many of them have been exhumed in various parts of the kingdom. The probability is that moulds were employed by the fabricators of base coin, just as they are at present. The substance of these illegal contrivances for making money is usually a baked white clay. Their thickness generally is about three-tenths of an inch at the edges; and within, this thickness is diminished so as to allow space for the coin. Each mould has a notch or indentation on one part of its edge, and which reaches to the recess in which the coin is produced. The flat shape and equality of the circumference of the moulds adapts them for joining together in such a relative arrangement as to bring the types of heads opposite to those of reverses, and in a position where the notches meet each other. Thus the furrow made by a line of these indentations served as a feeder to the series of connected moulds. In some instances ingots of debased silver have been found near the moulds, and the green rust of which indicated the large proportion of copper intermixed with the metal. One point in connection with these moulds is worthy of notice, and that is the excellent quality of the clay of which they were made. After the lapse of more than 1400 years the moulds are perfect enough to receive several castings!

In the French publication known as the *Histoire de l'Academie des Inscriptions*, tome iii., p. 218, there is to be found a paper entitled *Observations sur l'usage de quelque Moules Antiques de Monnoies Romaines decouvert à Lyon*, which goes to prove that the contrivances in question were the instruments of illegal coiners. After producing many arguments to prove that the only legal method of coining money among the Romans was the hammer, the writer asks, "What can we suppose these moulds to be, if they were not used by those forgers who superadded debasement to counterfeit casting by largely increasing the proportion of alloy?" This indeed is demonstrated by the quality of an ingot discovered at the same time and place, and which coincides with the system of forgery alluded to in the Theodosian code, in the following terms:—*Si quis nummum falsâ fusione formaverit, universas ejus facultates fisco oddici præcipimus, ut in monetis* *tantum nostris cudendæ pecuniæ studium frequentatur*—"If any one shall fabricate coin by false casting, we command all his property to be given up to the treasury, in order that the business of coining money may be carried on only by our own mints."

This way of counterfeiting coin was far more common than that of plating, from the time of Pliny, who remarks that it was so difficult to distinguish a piece of money which had been struck, from one which had been cast by a skilful forger, that this knowledge had in his day become a particular art, and that some of the pieces were so well fabricated as to induce the curious to give many good coins for a spurious one. The decline of the art of engraving under Septimius Severus was already very considerable, and the alterations which he introduced in the standard of money was favourable to forgers and false coiners, by rendering their deceptious more facile. The number of moulds discovered at Lyons and elsewhere has been so enormous, as to justify the otherwise incredible historical statement that under the Emperor Aurelius the forgers and false coiners formed a little army, who, for fear of the punishment with which they were threatened, revolted against him, and killed at the first onset 7000 of the regular troops!

Such moulds as have been described have been found at Ryton in Shropshire, and at Lingivel in Yorkshire. These comprise impressions of the Emperor Severus, of Julia his wife, and of Geta, Macrinus, Elagabalus, Alexander Severus, Maximinus, Plautilla, Julia Paula, and Julia Mammæa, besides a considerable number of reverses. Most of these moulds are in sufficiently good preservation as to admit of good casts being taken from them in sulphur coloured with vermilion.

Before leaving that part of our subject which has especial reference to the coinage, legitimate and illegitimate, of the Romans in Britain, it may not be considered improper for us to offer a remark as to the extraordinary variety of impressions which decorate the reverses of Roman coins generally. "If all our historians were lost to us," says Gibbon, "medals and coins would alone record the travels of Hadrian." The coins of the Romans were, in fact, their gazettes published in the most distant provinces; and they are to this day discovered in remote regions where our own records have never reached. Did they obtain a victory or reduce a province, coins were forthwith issued in vast quantities, upon the surfaces of which were depicted, more or less skilfully, the conquered people with their characteristic arms of warfare and costume. When the emperor afterwards visited the province in his capacity of pacificator, coins appeared upon which he was represented in a civil habit raising up the prostrate female who was the emblem of the country which had gained now the imperial favour. The remission of taxes, the raising of temples to their deities, and public buildings for the people, the celebration of games and sacrifices, and the records and traditions of early Rome, are all to be found depicted in infinite variety on the coins of the once mighty empire. They have been indeed, and are now, the admiration of the most eminent sculptors of this and other nations, and they speak eloquently of the high state of civilization to which the erstwhile mistress of the world had attained in her palmiest days.

The Romans, having kept possession of Britain for nearly 400 years, totally deserted the island about the middle of the fifth century; but on the invitation of the weakened and defenceless natives, the Saxons speedily occupied their vacant places. Ruding asserts that the new comers were ignorant, on their arrival, of the art of coinage, and that the Roman money continued to circulate for a long period among them and the Britons.

Undoubtedly the first coin of what may be termed the Anglo-Saxon period was the *Sceatta*. The term is purely Saxon, and conveys the sense of money or payment in a general way. The weight of the specimens which have been discovered varies with the rudeness of their workmanship. The value, however, of the sceatta is defined in the laws of Athelstan (who reigned from 924 to 940), where 30,000 sceattæ are said to be equal to 120 pounds. But 30,000 pennies would make 125 pounds, and therefore the sceatta fell short of the silver penny by one twenty-fifth part. The similarity in value of the two coins has induced some writers to assert that they were identical.[*] Besides the sceatta there appears to have been another coin at this period, and which was worth only the fourth of a penny. It occurs only in the reign of Ethelbert, king of Kent; but of what metal it was composed, or any other particular relating to it, nothing is known. In point of antiquity the penny succeeds the sceatta. It has not been possible, however, to ascertain exactly when this well-known term was first introduced. In the Anglo-Saxon records it is written, as was then very frequently the case with other words, in various ways; as, Peneg, Penig, Peninc, Pening, Penincg, Penning, and Pending. By some antiquarians it has been supposed to owe its derivation to the word *pendo*, "to weigh;" and by others to *punian*, "to beat or knock," which may be deemed to have applied to metal struck or coined. Of these theories, that which traces the term penny to *pendo* appears most feasible. At all events, the legal weight of the penny continued the same throughout the whole period of the Saxon government. It was always the 240th of their pound. Their laws, from the first mention of it to the last, give it this uniform valuation. Large sums were not unfrequently computed by pennies alone. In one instance a sum of 3000 pennies is named in reference to the purchase of lands. The Saxons had also halfpennies of silver, and fourthings, or farthings, of the same metal. But even so small a division as one-fourth of a penny was not sufficiently minute in value to answer the common purposes of exchange in those remote times, when an ox was sold for thirty pennies and a sheep for a shilling, as they were in the reign of Athelstan. Brass money was therefore coined under the name of Stycas, two of which were equal to a farthing.

All these coins, namely, the sceatta, penny, halfpenny, farthing, and styca are acknowledged by all competent authorities to be real coins of the period, and they are all to be found in the British Museum. Besides these there existed beyond doubt the Maneus, the Mark, the Shilling, the Thrimsa, and the Ora, but the precise value of some of these is not known, or at least is doubtful. It is also questionable whether gold money was coined at all during the Saxon *regime*. Certainly Athelstan was the first of the Anglo-Saxon monarchs who ordained laws for the regulation of the coinage, and he it was who ordained that there should be but one kind of money throughout the whole realm, and that no one should coin but in a town. If a moneyer (or coiner) should be guilty of fraud, it was ordered that his hand should be cut off and fixed upon the mint, and it is on record that this and other mutilations were actually performed upon the persons of dishonest moneyers during Athelstan's reign. At a later date (*temp.* Eadwig, 959), the crime of clipping coins was very general, and on one occasion, as a terror to evil doers in this direction, St. Dunstan refused to celebrate mass on Whitsunday until three depredators had undergone the usual punishment of amputation of their right hands. The sentence was forthwith executed, and certainly the operation was a strange and revolting prelude to a solemn religious service.

The whole of the legitimate coins produced during the Anglo-Saxon period were struck by force of hammer, which implement has indeed played a most important part in the annals of coining in this country, as it still does in remote parts of India.

(*To be concluded in our next.*)

BLACK DIAMONDS.

It will be recollected that at the Great Exhibition of 1867 there were shown some most singular *rognons* of a black mineral matter like anthracite to the eye, but of exceeding hardness, and taking a polish in the hands of the lapidary. Some of these remarkable concretions of carbonaceous matter, which were understood to have come from the coal mines of the Count de Douhet, were cut in diamond forms and mounted as brilliants for ladies' ornaments usually are. Their lustre, notwithstanding their nearly complete opacity, was very striking, and their reflection of colour from coloured surfaces, or by coloured light presented to them, still more so. In red light they shone absolutely like points of fire. This new and strange form of natural carbon has since been submitted to some careful examination, chemical and optical, by M. Dumas, by M. de Kokcharoff, and by Professor Miller of Cambridge. None of these able men have, we believe, been able to throw any new light upon the origin or circumstances of formation of these wonderful concretions of a coal seam. It has been ascertained, however, that they are constituted of two different materials, one very friable and brittle, the other intensely hard, and which gives the lustre to the whole. This portion is stated to be harder, more lustrous, *i.e.*, with a higher refractive index and greater reflective power, than the ordinary transparent diamond. One specimen examined by Professor Miller proves to be translucent, to what extent we are not aware; this is sufficient to prove that these *rognons* are not in molecular constitution only very hard anthracite, as has been conjectured. They appear in fact, so far as examination has yet gone, to be either a new and allotropic form of carbon, or a congeries of ordinary translucid diamonds packed together, the crystals being embedded in or intercalated with carbon in some opaque form, possibly that of graphite or of anthracite. In any view, the discovery appears to be one more step towards the final elucidation of the mystery of the production of the diamond in nature, and in so far one towards its ultimate production by art.

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[*] Mr. Clarke, a well known antiquarian, was of this opinion, and from the following considerations:—In the Anglo-Saxon days the fine for cutting off a thumb was twenty shillings, and for a thumb nail three shillings. If the toes were mutilated in a similar manner the penalty was one half less. The law says, *pro digitis pedis dimidium pretii sicut de digitis manus datum est.* Thus for cutting off the great toe the fine was ten shillings, and for the great toe nail, thirty sceattæ (*i.e.*), by the proportion given, one shilling and a half, and consequently twenty sceattæ to a shilling.

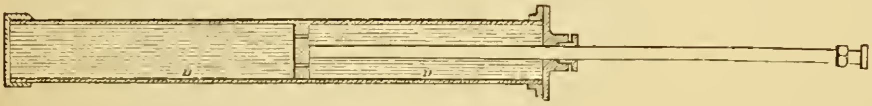
HYDRAULIC BUFFERS.

We believe there can be no doubt as to the success which has attended the application of "hydraulic buffers" for checking the recoil of heavy guns; so marked, indeed, does it appear to have been that Colonel Clerk, R.A., F.R.S., has been induced to consider the employment of the same instrument for preventing the destructive effects of collisions on railways. We have just been favoured with a copy of his proposals, which we append below.

It appears to us that the whole circumstances attendant upon collisions, with the existing systems of rolling stock and permanent way, have not been fully taken into consideration by the proposer. The conditions of a gun's recoil and of train collision are in many respects different.

For instance, in the former, the insistent weight of the gun on its slide, and to which it is fitted so as to traverse thereon very smoothly, provides for the blow of the recoil being steadily resisted by the securely-fixed buffers; there is no risk in this case of the parts being at any time out of their proper relative positions. But on railways the case has to meet such difficulties as the following: with the existing rolling stock, it is a rare thing to find the buffers of the engines and carriages in direct line with each other. Either the buffers of one or the other are too high off the rails or too near them, or too much at one side. This with short, stumpy buffers, as now used, is not of very great importance, but with a buffer rod 6 feet long, such as Colonel Clerk proposes to use on his engines, provided, too, as he has shown, with heavy globular ends, and projecting out from the hydraulic cylinder without any continuous support, it would simply be impossible to keep the buffer rod for any moderate length of time firmly fitted to the cylinder. Even with the present short and light buffers they work loose in less than six months, through the wear and tear of vibratory strokes and the consequent working due to blows and sinuous movements; but with a long, heavy buffer, such as Colonel Clerk proposes to use, the evil effects would be immensely increased, no matter how well fitted the cylinder and buffer rod might be at first, and with bearings of the greatest length that it would be practicable to employ with our present types of locomotives.

Fig. 1.



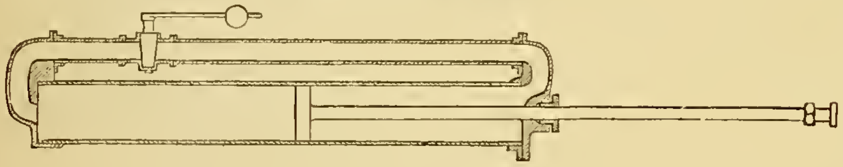


Fig. 2.

In the event of a collision between a pair of engines, or engine and carriage fitted with buffers of such an enormous length, if these met on a perfectly straight bit of road the shock might perhaps be straightly and effectively met; but if such buffers met on a piece of curved road they would be situated at an angle to each other, and even if they struck each other in the centre, they would almost certainly be deflected from each other and become bent off to one side, jamb in the hydraulic cylinders, which unless made very heavy and strong, would be split.

Besides the foregoing few difficulties in the way of applying a *long* hydraulic buffer, now proposed, we fear there are several others, perhaps some more serious.

The idea of an hydraulic buffer is not new; it was, we believe, used under different circumstances, to resist a steady pull in place of a heavy, sudden impact, by Mr. W. Froude, in a dynamometer which he constructed a few years ago, for ascertaining the resistance or pull to be overcome by horses in drawing ploughs. In this case the liquid used was oil. An hydraulic spring, dependent on the combined action of water and compressed air, was proposed at least thirty years ago, by the late Sir John Robison of Edinburgh, and tried upon the Paisley Canal, as a means of easing the jerking pull of the horses yoked to the swift passenger fly-boats.

Hydraulic and air buffers were proposed for application to railway carriages by Messrs. R. Mallet and John Somers Dawson, railway carriage builder, at least twenty-five years ago, were constructed on the large scale, and tried upon the Dublin and Kingston Railway, Ireland. The case there was however very different to what is now proposed by Colonel Clerk, whose notion, we must not hesitate to say, we believe wholly impracticable.

An account of the above trials will be found in the back volumes of the *Mechanic's Magazine.*

Anterior to all these, however, is "Hardy's Lowering Cylinder," which is in fact identical, both in principle and construction, with one case of what is here proposed.—V. D.

On the Application of "Hydraulic Buffers" to Prevent the Destructive Effects of Railway Collisions.

By Colonel H. Clerk, R.A., F.R.S.

In consequence of a suggestion made to me last year by C. W. Siemens, Esq., C.E., F.R.S., to try the effect of water to check the recoil of heavy guns, I submitted to the Secretary of State for War a compressor or buffer on the above principle. It has been tried with guns varying in weight from only 150 lbs. up to 18 tons, and in all cases the results have been most satisfactory. The amount of recoil can be regulated to a great nicety, and the motion was smooth and regular, while no sensible increase in the temperature of the water was observed.

It consists of a wrought-iron cylinder (fig. 1) closed at one end, the other end fitted with a cap and stuffing-box, through which a piston rod passes. The length of the cylinder and piston rod are regulated by the amount of recoil required, or the space within which it is necessary to bring the moving body to rest. The piston fits well into the cylinder, and is perforated with four small holes. The ratio between the diameter of these holes and that of the cylinder is determined by the amount of work required to be performed on the water with which the cylinder is filled, enough air-space, *a*, *a*, being left to allow of the displacement of water by the length of piston rod due to the recoil.

This air-space also acts as an elastic buffer, and takes off the violence of the first impact of the piston on the water.

The cylinder is firmly attached to the platform on which the carriage recoils, and the end of the piston rod to the carriage itself; so that on the discharge of the gun, the carriage drives the piston through the water with an initial velocity (V), whilst the water has to pass through the holes with an initial velocity (R V), (R) being the ratio between the area of the cylinder and of the holes.

For sea-service, on account of the rolling motion of the ship, a modification of this arrangement has to be made (fig. 2). The piston has no holes in it, and a small connecting pipe leads from one end of the cylinder to the other, on the outside, through which the water is driven. In this pipe there is a regulating cock, to increase or diminish the aperture through which the water flows (and consequently the value of R), as may be required.

The satisfactory manner in which this buffer has worked in checking the recoil of a gun of 18 tons weight, leads me to anticipate that it could be most usefully applied towards preventing, or very sensibly diminishing, the destructive effects of a railway collision.

The object of this paper, therefore, is to bring this important subject to the notice of civil engineers and the railway authorities, so that no time may be lost in making some preliminary trials to ascertain if this desirable object cannot be effected; and I shall be most happy to assist at these trials, and to give any further information that may be necessary.

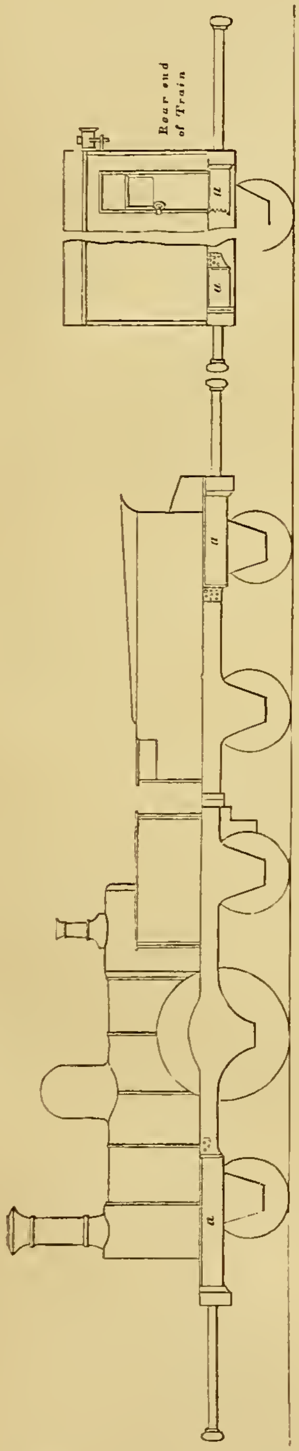


Fig. 3.

My proposal is that every railway engine should have two of these hydraulic buffers in front (fig. 3), so that the piston rods (drawn out) should project about 6 or 7 feet beyond the engine. In the event of a collision, the impact would take place on the end of the piston rods, and they would be driven back through the water.

The ratio of the area of the cylinder to that of the holes in the piston would be such that the work done upon the water in 6 feet, should equal the force of impact, in which case the engine would be brought to rest in the 6 feet, or before any actual collision had taken place between it and the opposing body.

To the rear of the tender there should be fixed another pair of buffers, to act between the engine and the other carriages of the train. The piston rods of these buffers need not be more than 4 feet in length; but to the break van or last carriage of the train, there should be attached two buffers, with 6-feet piston rods, so as to diminish the concussion in case of the train being run into.

It would be also of great advantage if every carriage were fitted with a pair of buffers, both in front and rear; the stroke of the piston with them need not be more than 18 inches.

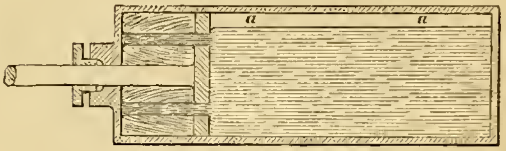
With these precautions, although there will always be a certain amount of concussion due to the sudden stoppage of the train, still I feel convinced that the destructive effects will be almost entirely rendered *nil*, and that a great saving, both of life and property, must ensue.

As by means of this hydraulic buffer a force of impact varying from 1200 foot pounds, up to 54,000 foot pounds, has been easily overcome in distances from 16 to 60 inches, and on inclinations varying from + 10° to — 4°, I see no reason why the principle should not be extended to overcome a force of, say 1,500,000 foot pounds in 72 inches.

The following formula, which has been used in calculating the dimensions of hydraulic buffers for several experiments to check recoil, together with the theory on which it is based, have been drawn up and investigated by Mr. H. Butter, the constructor of the Royal Carriage Department, and in all cases it has been found to give accurate results.

On the discharge of the gun, or the impact of any moving body, the piston is driven forcibly against the water; the pressure thus exerted causes the water to flow in the direction of the least resistance, namely, into the air space, *a*, *a*, and through the holes, *b*, *b*. As the pressure continues, the air becomes more and more compressed, and reacting on the water, gradually increases the velocity with which it passes through the holes; at a certain point the air is compressed to its minimum, and the velocity of flow is then at its maximum; from this point the velocity gradually diminishes, until the moving body is brought to a state of rest. (See fig. 4.)

Fig. 4.



The air thus serves the purpose of an elastic cushion, and causes the pressure to be gradually applied to the water. The air-space is also essential, in order to provide for the displacement of the piston rod. In practice it has been found desirable to allow about $\frac{1}{7}$th greater volume of air-space than the solid content of the piston rod.

It will be seen at once that the main resistance offered to the moving body arises from its having to impart a high velocity to a certain weight of water; the resistance due to the compression of so small a quantity of air is so trifling that for all practical purposes it may be omitted from consideration.

Confining attention, therefore, at present to the water, its initial velocity is nearly x R V, where R is the ratio of the area of the cylinder to that of the discharge holes, V the initial velocity of the piston, and x a correction, the nature and value of which is to be determined from data derived from a number of experiments embracing a wide range of varying conditions.

The reasons for assuming the necessity of having such a correction, and of seeking its value from actual experiments, are—our imperfect knowledge of the true value of the *vena contracta* of streams issuing at high velocities through plates of metal; our ignorance of the effect on the piston of the reaction of the discharged water, and any other sources of error likely to influence the velocity of flow.

Taking x R V to represent the initial or highest velocity of the water, the height from which a body must fall to gain such a rate of motion is $\frac{(x\,R\,V)^2}{2g}$; and assuming, as the basis for the construction of an empirical formula, that the reduction of velocity is uniform, then the mean height from which the whole body of water acted upon would have fallen, is $\frac{1}{2}\,\frac{(x\,R\,V)^2}{2g}$, or $\frac{(x\,R\,V)^2}{4g}$, and, therefore, the total resistance offered by the water to the advancing body is

$$\frac{w\,(x\,R\,V)}{4g}$$

The expression 62·5 lbs. A l may be substituted for w; 62·5 lbs. being the weight of a cubic foot of water, A the area of the cylinder in feet, and l the length, also in feet, of the column of water acted upon; or

$$\frac{w\,(x\,R\,V)^2}{4g} = \frac{62{\cdot}5\,A\,l\,(x\,R\,V)^2}{128{\cdot}8} = 0{\cdot}485\,A\,l\,(x\,R\,V)^2 \quad . \quad . \quad \text{I.}$$

If W be the weight of the body in motion, and V, as before, its initial velocity at the moment of impact, then the total accumulated work is $\frac{W\,V^2}{2g}$: this work has to be absorbed by the resistances of friction, gravity, and the water. The first two are of great consequence in the case of gun-carriage recoils, but less so in that of railway trains coming into collision. Their value is represented by the expression

$$W\,L\left(f.\cos\theta \pm \sin\theta\right)$$

L being the length of recoil, or distance after impact, which the body travels before being stopped; θ the angle of inclination of the plane upon which the body moves; and f the co-efficient of friction.

Calling U the remaining work, after deducting the effects of friction and gravity,

$$\text{or } U = \frac{W\ V^2}{2g} - W\ L\left(f.\cos\theta \pm \sin\theta\right) \quad . \quad . \quad . \qquad \text{II.}$$

therefore, in order that the moving body may be brought to rest, I and II must be equal

$$\text{or } U = 0{\cdot}485\ A\ l\ (x\ R\ V)^2 \quad . \ . \ . \ . \ . \ . \ . \ . \qquad \text{III.}$$

$$\text{and } x = \sqrt{\frac{U}{0{\cdot}485\ A\ l\ R^2\ V^2.}} \quad . \ . \ . \ . \ . \ . \ . \qquad \text{IV.}$$

From a number of experiments, it has been ascertained that the values of x are uniformly represented by the expression $\frac{16}{\sqrt{R\ V}}$, and substituting this in III., we get

$$U = 0{\cdot}485\ A\ l\ R^2\ V^2 \frac{256}{R\ V}$$

$$= 124\ A\ l\ R\ V \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \ . \qquad \text{V.}$$

From this equation the values of l or R may be readily ascertained, the value of one being given; and L, the total recoil, equals $(l + s)$ where $s =$ the length of stroke due to the air space.

The following example will illustrate the practical application of the formula:—

Suppose a locomotive engine and its tender, weighing 50 tons, and travelling with a velocity of 44 feet per second (30 miles per hour) are required to be stopped in the space of 6 feet, and further assuming the engine provided with two hydraulic cylinders, each 1 foot internal diameter, and admitting of a 6-feet stroke:

$$\text{Then } U = \frac{44^2 \times 50 \text{ tons}}{2g} = 3{,}366{,}956 \text{ foot pounds,}$$

and neglecting the effect of friction, the resistance required of each cylinder is 1,683,478 foot lbs. Allowing 9 inches 0·75 feet of stroke to be required for the air-space (using a 4-inch piston rod)

$$l \text{ will become } 5{\cdot}25 \text{ feet}$$

$$\text{and } A = {\cdot}7854 \times 1 \text{ ft.} = 0{\cdot}7854.$$

Substituting these values in equation V we have

$$R = \frac{U}{124\ A\ l\ V} = \frac{1{,}683{,}478}{124 \times 0{\cdot}7854 \times 5{\cdot}25 \times 44} = 74\ 8.$$

Let $D =$ diameter of cylinder $= 12$ inches

$d =$,, each hole, of which there are 4;

$$\text{then } R = \frac{D^2 - 4\,(d^2)}{4d^2} = \frac{144 - 4d^2}{4d^2} = 74{\cdot}8$$

$$\text{and } d = 0{\cdot}7 \text{ inch.}$$

Therefore, if the above engine were fitted with two cylinders, 12 inches internal diameter, with pistons having 4 holes, each of 0·7 inch diameter, it would be brought to rest in a space of about 6 feet.

There are two important problems to be worked out by the railway authorities:—

1st, "To have no railway collisions."

2nd, If they must sometimes occur,

"To render them as harmless as possible."

It is with the second of these that this paper deals.

IMPROVEMENTS IN THE OXYHYDROGEN LIGHT.

M. le Commandant Caron has found that zirconia answers much better than magnesia or lime for the production of intense light in the oxyhydrogen flame. But the scarcity of the former earth in nature offers a serious obstacle to the substitution. The main mineral source of zirconia, in fact, consists in operating upon crystals of zircon, which are always scarce, and have become increasingly so. It appears, however, that a new source of these crystals has been suggested by the Abbé Moigno, and that a mineralogist, M. Bertrand de Lom, despatched into the district of Vélay has, after a very brief search by washing, returned to Paris with no less than five kilogrammes of zircon crystals, as the first fruits of his labour. Zircons are said to exist very abundantly in the gold formations of the Oural, and the Russian government has already sent to M. Tessie du Motay, who is engaged with this improved light, a considerable mass of crystals. Independent of this new use for zirconia or oxide of zirconium, how much to be desired it is that the oxide or earth should become sufficiently plenty to enable some chemist of the St. Claire de Ville type, and having sufficient means at his command, to reduce it, and present to chemistry and physics some large bars of the metal zirconium. Here is one of our so-called chemical elements, known to be a metal now for nearly half a century, and yet up to the present hour no chemist or physicist knows any thing of its properties, except from vague analogies. Aluminium was in the same predicament a few years back, magnesium is but emerging from it. Calcium, barium, and strontium are absolutely unknown still, as well as zirconium; yet the high probability is that not one of these metals but would be found to possess peculiar and valuable properties in the arts, if once obtained in large examinable and workable masses or bars, in place of being limited to a few miserable round grains, or a little powder almost or altogether without metallic appearance, which is the state that chemical lecturers are content, year after year, to present these metals unto their classes.—Ed.

RECENT DISCOVERIES OR IMPROVEMENTS.

The French government is at present engaged in the construction of a magnificent suite of laboratories in Paris, for the pursuit experimentally of the higher physics and chemistry, as well as their applications. This inauguration has no doubt been urged on by the like move made upon so noble a scale three years ago, by the Prussian government, in the vast laboratories established at Berlin and at Bonn. In both countries, knowledge, pure science, is promoted and reverenced, as not alone good in itself, as seeing that the deciphering the unknown in the universe is the highest intellectual function given to man, but as the true handmaid to all applied knowledge worthy of anything. In England—scarcely to the same extent in America, though yet somewhat there too—alone amongst the nations that call themselves centres of civilization, is it the fashion, permitted without notice or rebuke, to sneer at all knowledge that cannot be immediately converted into cash, and at all men whose scientific walks have not been such as the mob can see yield results in solid pudding; the only real exceptions are amongst the workers in science themselves, and they are few and far between. In Great Britain such a thing as a national *physical* laboratory does not exist, to say nothing as to scale, or in comparison with the grand institution now being created under the direction of M. Jamin by the government of France. Nor indeed in a strict sense do we possess a national school, much less laboratory, of chemistry; and yet ours is the country that declares it intends to keep in the van of all science, and of all its applications, do what the rest of Europe may to run up alongside of us. In some things, and in this of true scientific training and national means towards it, and in the applications of the same, and in technical education as the means to that, we had best beware of being "a nation too full of beef and conceit," as was bluntly said of us by an able German not so long ago. The French government has taken a step beyond Prussia, however: for besides these grand laboratories at Paris, which it is said they propose extending to one or two also of the great provincial cities, they are about to organize into certain modes of common or concerted action, both as to investigation and instruction, all the provincial laboratories of the whole of France; so that great questions of universal importance in the abstract, and questions of primary importance in the way of application, shall receive at the same time, in distant quarters of France, co-operative and mutually assisting and energizing research.

Mons. Dabry, the consul of France in China, has communicated to his government the fact that the Chinese have adopted a method which appears effectual in the preventing or removal of the *new* vine disease, said to be due to a peculiar insect. The method consists in rubbing and coating the bark of the vine, stems and stalks, with a mixture of flowers of sulphur and aluminous clay, mixed into a thick mud or paste.

It has been proved by M. D'Ivernois in France, that the seeds of the *Acacia lophantha,* merely scattered broadcast upon the driest and most stony and desert soil, such as that of certain parts of Algeria, and of Hyères (Var), take root at once, and grow into bushes 4 to 6 feet high in the first year. The wood of this acacia, an African native, is of value for many purposes; but its climatic effects in certain arid and disafforested countries, such as Spain, parts of southern France, and vast tracts in India, are likely to prove of great and its greatest value. A more recent proposition is to lease off the slopes of the French railways for the plantation of orchards and other fruit gardens. To a very small extent this has been already done, and with some success, in the way of strawberry beds; but it is quite worthy of extension as at once a profitable investment of land and labour, not necessarily injurious to the maintenance of any railway, and adding a beautiful feature for delight of the traveller.

A new source of fluorescent light, of great beauty and interest, has been discovered by M. Goppelsroeder (*Pogg Ann.*, Part cxxxiv.). The alcoholic tinctures of the yellow wood of the dyers' mulberry (*Morus tinctoria*) are not fluorescent; but if to such a tincture a solution of a salt of alumina be added, and that we then neutralize part of the acid, the slightly turbid solution becomes fluorescent, and the light emitted is of a magnificent green. One method and the easiest of producing the required solution, is to mix some alcohol and pure hydrochloric acid slightly diluted with water, upon the yellow lake made from the *morus*, and sold in the colour shops. The same phenomena are *not* manifested with the tincture of the *Tannius moriniquus*, another dyewood often adulterated with the *morus*, and this fact gives the means of detecting the slightest admixture of the latter dye-wood, if occurring in commerce.

DESCRIPTION OF THE GREAT MELBOURNE TELESCOPE.

Constructed by Thomas Grubb, Esq., F.R.S.

(*Illustrated by Plates* 10 *and* 11.)

Owing to an accident at the last moment, we are compelled to postpone the publication of Plate 11 *till our next.*

Those who are privileged to visit the chambers of the Royal Society will see amongst the relics of those who have left after them, to their own memories and to the society, the deathless fame of great discoveries, a little wooden tube of some foot and a half long, and about three inches diameter, mounted on a rude, little, wooden ball and socket jointed foot, and covered by a large glass shade. This is the first Newtonian reflector, made by the hands of Newton himself about 1671 or 1672, which showed him Jupiter's satellites, and which, rude and insignificant as it looks, is really the precursor of the large and magnificent instrument now on its way to the antipodes.

Through the kindness of Mr. Grubb himself, whom the writer has had the advantage and pleasure for many years to reckon amongst his friends, and with the zealous aid of Mr. Howard Grubb, who inherits much of his father's mechanical genius, we are enabled to lay before our readers the following account of this great telescope, with illustrations and descriptions of its constructive details, the most complete as yet published.

Telescope-making upon the scale before us, is no longer matter for the "optician" or "instrument maker," in the ordinary sense of these titles, to deal with; superadded to the knowledge of the practical astronomer and the mathematical attainments of the physicist, it demands the very highest resources of the mechanician in devising and deciding upon the combinations of its parts, and the practical judgment and skill of the mechanical engineer upon the great scale.

Half knowledge, which is in some cases ignorance, may grudgingly credit this perhaps. We can fancy some of our great "tool-makers" or "engine-makers" saying, "There can't be much in this telescope-making after all. I can make a 40-foot turntable, upon which two men can sweep round a 40-ton locomotive and tender like a feather, and you can't feel a shake in it at all, no more than if it floated on oil." Quite true; you might feel no shake, but if you had upon your moving turntable a telescope magnifying no more than the little one of Newton, and turned it to a fixed star, you would find you could see nothing—or if anything, a blur or a curved and twisting knot of luminous lines, like those produced by the ignited end of a stick when flourished about in the air.

Those concerned in any way with mechanical combinations must then, though neither astronomers nor instrument-makers—though these classes too are amongst our readers—take an interest, and ought to derive advantage from studying the methods in detail, by which not alone absolute steadiness, and yet a mobility almost marvellous, united to durability of parts against the effects of friction and wear, and the capability of following the apparent path in the heavens of any point of light upon which the line of collimation of the telescope has been directed, have been attained with this ponderous instrument of eight tons in weight. It is the largest and heaviest telescope that has ever been equatorially mounted, and so exquisite are the adjustments and balance of its parts, that an extraneous force of five pounds acting at 20 feet from the centre of motion suffices to move the mass. What is meant by equatorial mounting, it may be here well to explain, is that the body of the telescope is mounted upon two axes at right angles to each other. One of these, the "polar axis," is fixed parallel to the axis of our own planet; if that be fixed, the telescope moving round upon the other or declination axis, of course sweeps the whole visible arc of 180°; and as the instrument is so balanced upon the declination axis that it can be turned over 90° on either side round the polar axis, so then the telescope can sweep an arc of 180° in a plane at right angles to the former one, and in fact can be directed to any point of the heavens above the horizon of the place.

Moreover, as the effect of this mounting is the same as if the telescope were mounted on a universal joint situated in its centre of gravity, and as any ratio may be given to the movement simultaneously, around each of the two axes, so if these movements be controlled by a clock going sidereal or lunar time, and of sufficient motive power, the telescope may be made to follow a star or planet constantly, as the apparent vault of heaven sweeps over the head of the astronomer.

The history of the origination of this telescope is as follows:—Ever since the days when the elder Herschell, aided by the liberality of King George III., made for his day and for the then slightly developed state of the mechanical arts, such an advance at one stride in the construction of reflecting telescopes of great size, and showed even upon the very second night after his great telescope was completed, what such instruments can do for astronomy, by the immediate discovery of the satellites of Uranus, it had remained a great object with astronomers to still further improve these great instruments, and to apply them not only to the better examination of the northern, but to that of the southern hemispheres—previously to Sir John Herschell's astronomical residence at the Cape of Good Hope almost completely unexplored.

The Royal Society had many years since formed a committee which reported to government on the importance of such steps. The late Lord Rosse had steadily and for several years, pursued the work of his life, the perfecting the means of casting and polishing to true figure great metallic specula, as the first great step towards such telescopes, and had at length proved his success by the construction of his two great reflecting telescopes at his own house, Birr Castle, in Ireland. Others, such as Lassells and Nasmyth, and several others, had also been at work in the same direction. Amongst those, and at a very early period, was Mr. Thomas Grubb, who, when quite a young man, and long before he had acquired his present well-deserved reputation, had made several reflecting telescopes in Ireland of what was then deemed considerable size, and the performances of which were admittedly good. Nothing came, however, of the representations made by our foremost men of science to our home government, and it was reserved for the government of one of our greatest colonies, for that of Victoria, which had already established an observatory at Melbourne, to surpass in zeal, liberality, and intelligent progress, that of the old country whence it sprung.

In 1862 the Victorian government communicated its desire to construct a telescope worthy of being employed for the exploration of the southern hemisphere and of its nebulæ, and applied through the duke of Newcastle to the Royal Society for advice and assistance, having at the same time made the liberal grant of £5000 (a sum since, we believe, increased), to be devoted to the production of the instrument. The committee of the Royal Society again reported; the authority to act on its advice and to proceed with the telescope was given by the Victorian government in 1865, and in 1866 a contract for £4660 was signed by Mr Grubb to construct the telescope in general accordance with the conditions prescribed by the committee deputed to manage the work by the council of the Royal Society, and consisting of the late Lord Rosse, Dr. Robinson, astronomer, Armagh Observatory, and Mr. W. De la Rue, the present Lord Rosse taking place on the committee after his father's decease. The committee decided the following points:—1st, The telescope was to be a reflector of four feet aperture, and not an achromatic. 2nd. It was to be mounted equatorially. 3rd. The specula were to be metallic, and not of glass silvered by Foucault's process. 4th. The tube of the telescope was to be of open lattice work, a construction proposed by Sir John Herschel and tried by Lord Rosse, Mr. Lassells, and Mr. W. De la Rue, with the immense advantage of reducing the evils incident to the fluttering of currents of unequally heated air in close tubes. 5th. The telescope was to be of the construction known as that of Cassegrain, and not on that known as the Newtonian, nor yet on that of Sir William Herschel. The Cassegrain construction was chosen from the great convenience and facilities it affords to the observer.

Beyond these conditions to be observed, we believe we are correct in stating that the entire construction of the telescope, from its general design to its numerous and minute constructive details, is due to and the work of Mr. Grubb himself, constantly aided and sustained, of course, by the efficient and zealous advice of Dr. Robinson and Mr. De la Rue, both men pre-eminently fitted to advise upon such a subject, by their in each case rare combination of exact scientific and practical knowledge.

The telescope (except the photographic apparatus and spectroscope added at a later period) was finished, including twice casting the first speculum, in twenty months or a little more.

The committee went to Dublin, tested and examined the instrument by actual observational use at Mr Grubb's works, where it had been temporarily erected, and in April last reported the work accomplished, and in their report to the Royal Society convey a well-deserved tribute of praise to Mr. Grubb, for the perfect manner in which he had performed all that he had undertaken. The sum voted by the Victorian government, however liberal, was a small one to defray the cost of such an instrument as this, and those of our readers accustomed to the careful work of the tool-maker's or engine shop, will agree with us in thinking that the price at which Mr. Grubb undertook the work was one not free from hazard.

Probably Grubb felt much like Wren when some of his court friends marvelled that for £500 a year he was content to risk his life daily in being hauled up in a basket to inspect the growing dome of St. Paul's; and that money was a secondary consideration with him to that love of undying fame which is always more or less the condition of great achievements. We have heard that, in fact, he has not lost by the work, but neither has he reserved a profit beyond the reputation and satisfaction of success.

We proceed to the telescope itself, which will be now best understood by explanation of the several illustrations. Fig. 1 on Plate 10 presents a general elevation of the telescope as actually constructed, seen from one side, the instrument being directed towards the pole.

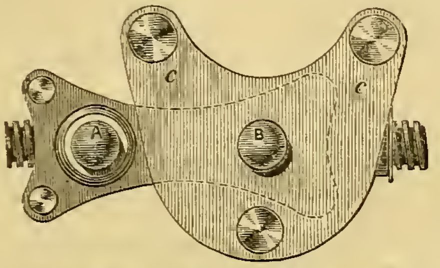
Figs. 2, 3, and 4 are details hereinafter referred to. A is a foundation platform of solid masonry, on which stand B, B, the polar and equatorial piers, carrying the upper and lower bearings of C, the polar axis, D is the sector worked by E the endless screw, connected to the clock by the shafts, *e*, *e*; F, the clamp by means of which the sector is clamped or unclamped to the polar axis; *f*, one of the two square arbors for Hook joints, by means of which is obtained slow motion in R. G is one of the two hand wheels for quick motion in R, communicating by the shaft *g*, with H, a pinion and toothed wheel attached to P, A. I is the sector for relieving the lateral pressure on lower bearing; K, the roller, which performs the same duty for the upper bearing; L, the chain and lever attached to the polar axis by the cranked arm *l*, by which the end pressure of the polar axis is relieved from the lower pivot. This chain is made up of circular discs of iron, connected by semicircular links of steel, formed in such manner as will readily twist a small quantity on each other with little friction, being hardened at their points of contact. The ends of the semicircular steel links pass through holes in the discs, and are attached by nuts on the other side, so any link can easily be replaced, if injured. N is the sector and lever connected with the internal apparatus for the relief of that portion of the friction of the declination axis which is exerted in a direction at right angles to the polar axis. O is one of the two side levers (centred in the cast-iron cube of the polar axis) which act upon the two centre friction frames to relieve the remaining portion of the friction of the declination axis. P is one of these frames; the other being concealed by the declination clamp; R, the fixed and differential hour circles; R′, the declination circle; S, the declination clamp ring for slow motion, carrying also a toothed wheel, in which gears a pinion, V, for quick motion; T, the telescope; U, the counterpoise weights; V, the wheel and gearing for quick motion; W, tangent screw and gearing for slow motion; X, the finder telescope; Y, the small convex mirror, adjusted to focus by *y*, a hand-wheel, to which it is connected by wire-cords passing down side of tube; Z, the clockwork in its niche, connected with the endless screw by the shafts, *e*, and the piece of differential wheelwork, *z*, for adjustment to lunar rate.

Fig. 2 is an elevation, and fig. 3 a section of the upper bearing of the polar axis, scale 1½ inch to the foot. The axis in this part, 12 inches diameter, rests on two gun-metal blocks, *a*, *a*, inserted in a pair of wedge-shaped castings, *b*, *b*, sliding in a groove prepared for them, and acted upon by two screws, *c*, *c*. By this means the axis can be adjusted in the direction of the plane of the meridian, or at right angles to it. At *d*, fig. 2, is seen the roller and lever by which any desired portion of the weight can be raised from the Y bearing. The chain and weights from this, hang down the eastern side of pier (whose plane is in the medidian). At *e* is seen the sector and lever which, by means of weights hanging down the western side of pier (seen in general view) acts upon the "internal apparatus for the relief of friction of the declination axis," described more particularly elsewhere. The form of the sector allows the bar, *f*, to roll in it as the axis turns round. Fig. 4 is a view, partly sectional, of the lower bearing of the polar axis, scale 1½ inch to the foot; *a* is the end of the polar axis, terminated by a piece of cast iron, chilled and polished on its lower face, *b*. This polished face revolves in contact with a piece of bell-metal, *c*, formed with a spherical annulus on its lower side, which fits into a similarly shaped ring formed to receive it at the bottom of the plumber block. This arrangement allows of the axis being adjusted by the screws, *c*, *c*, figs. 2 and 3, into parallelism with the pole of the earth, without impairing the perfect uniformity of the bearing of the contact surfaces of *b* and *c*. Although the component of the weight of the telescope acting in this direction equals about 5 tons, any desired portion of this can be relieved by the chain and lever on upper pier, seen in general drawing; this effectually prevents any danger of "biting" of the pivot or bearings surfaces. At A is seen the sector for relieving the lateral friction of this bearing. This sector working on a hardened steel pin, *d*, is forced up by the screw, *e*, and lamina of steel springs, *f*; the sector being 27° radius, and working on a 1-inch pin, the friction for the most part is reduced in the proportion of 54 to 1. At B are seen the fixed and differential hour circles; the lower fixed one reading as usual (Sid. Time—*i.e.*, right ascension), and the upper being set to Sid. Time, the differential verniers read actual right ascensions. The differential circle is roughly set by the pins, *g*, and finally and finely by a clamp and tangent screw.

Fig. 5 (Plate 11) is a plan of the right ascension clamp and clock sector, scale, 1½ inch to the foot; A is a cast-iron piece which is strung on a portion of the polar axis, carefully turned and ground immediately above the hour circles, its bearing is 7½ inches diameter and about 5 inches long. To this are attached two steel tubular arms strongly trussed with cast-iron lattice, which carry on their extremities the gun-metal sector, C, ratcheted on the edge for the clock screws; B is the clamp, 20 inches diameter, which is clamped or unclamped to the axis by half a turn of either of the screws, *a*, *a′*. This clamp ring is prolonged into a lattice arm carrying on its extremity the link motion and tangent nut connecting it by the screw, *b*, to the sector. So long as the screws, *a*, *a′*, are not tightened, all this apparatus is quite independent of the polar axis, which can then be turned by the quick-motion gearing; but if these screws be tightened and the clock set going, it carries the telescope at its proper rate by this sector and clamp; and Hook's joints handles, being attached to either of the square arbors, *c*, *c′*, a differential motion is produced between the sector and clamp equally available for a slow motion, R, whether the clock be in motion or at rest.

Fig. 6 (wood-cuts) is a plan, and fig. 7 a section of the link motion for the tangent screw, scale ½ size. The masses and weights of the moving parts of this telescope are so great, that the ordinary appliances for this purpose were considered insufficient. This plan (used for the first time in this instrument) combines strength, steadiness, and ease of motion. The tangent screw is supported in bearings at both ends, and in such a manner as to avoid all end shake; this necessitates that the nut shall work in a straight line, while the arm which carries it describes an arc of a circle. In figs. 6 and 7 (cuts), *a*, *a*, is the nut which rocks on a pair of trunnions, A, in the small inner carriage frame, *b*, *b*; this itself works on a pair of trunnions, B, in the outer frame, *c*, *c*, attached to the clamp arm. Any loss in the screw caused by wear is removed by the counter nut, *d*, kept in its position by a cap, *i*, a pair of feathers in which enter into one or other of a set of teeth into which the end of the nut is cut.

Fig. 6.



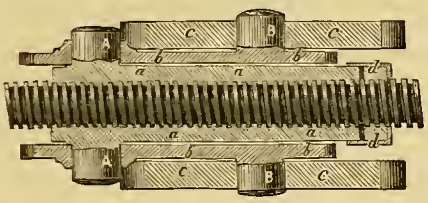


Fig. 7.

Fig. 8 (cuts) is an end, and fig. 9 a side elevation, of the small mirror and mounting, to scale, $1\frac{1}{2}$ inch to the foot. *a* is a light cast-iron girder 18 inches long, bolted at one end to a small cross girder, *b*, and at the other to a lunette steel ring, *c*. To this is attached by two thumb screws, so as to be easy of removal, the plate, *d*, which forms the base for the hollow steel-plate arm, A, carrying on its upper end the slide-box, B, in which slides the V-shaped gun-metal arm, *e*. To one end of this is attached the speculum box, C, a couple of rings, *f*, *f*, of unequal thickness on opposite sides, being introduced between the speculum box and plate forming end of V-bar, for the purpose of adjusting the mirrors.

Fig. 8.

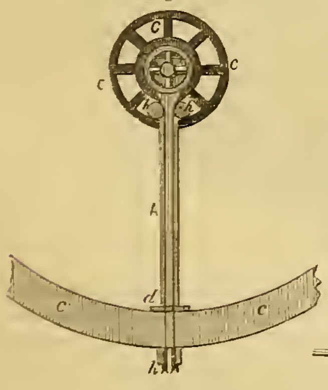
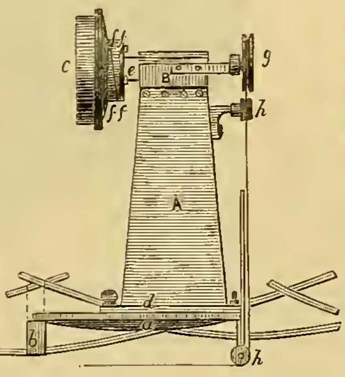


Fig. 9.



In the other end of this V-bar works a quick threaded screw having a pulley, *g*, from which wire cords are carried over the guide pulleys, *h*, *h*, down the side of the tube and over a hand-wheel placed concentric with the eye-piece—(see fig. 10, Plate 11). Fig. 10 is a plan of the lower end of the tube, being in fact the back of the speculum box, scale 1 inch to the foot. A is the focusing wheel mentioned above. B is the wheel and handle for quick motion in declination. A pinion on the shaft of the wheel, *a*, gears into a controle wheel 4 feet 6 inches diameter, attached to the cube of the polar axis. C is the wheel for slow motion in declination. It works the tangent screw, *b*, connected to a clamp ring 4 feet 6 inches diameter attached to the cube of the polar axis. This tangent screw has a link motion apparatus exactly similar to that described for R (figs. 5, 6, and 7); D is the lowest power eye-piece, power 220, field about 14 inches, and field lens 8 inches diameter; E is the Hook's joint handle for slow motion in R, described (fig. 5); F, the finder 4 inches in aperture and furnished with eye-piece of low power and large field. The telescope itself is furnished with nine eye-pieces varying from 220 diameter to 900, besides the micrometer furnished with three pieces. Fig. 11 (Plate 11) is an elevation of the clock governor, showing the apparatus for adjusting the rate. In the construction of this governor, one which had been made several years ago for the telescope in which Sir J. South's object glass is now mounted, was made the model, and the various plans extant for connecting a pendulum to the governor were tried, but without success. It was therefore decided to use this clock without a pendulum connection; and so well does this apparatus work, that if the clock be rated with a weight that will just keep it going, and that then that weight be doubled, the clock will be found to have increased its speed only 10″ per hour or $\frac{1}{360}$th part. It is therefore very evident that those clocks, which, constructed on this plan, have been found defective, are so, not from the principle of their construction, but from their faulty proportions. There are several points which *must be* proportioned in a certain way, and in this clock these matters have been rigidly attended to; hence its success. When the clock attains its speed, the balls which are of brass, hollow and filled with lead, swinging on their points of suspension *d*, *d*, are raised from the piece, *c*, which serves to hold them nearly in their working position until the points of the screws, *a*, *a*, are brought into contact with the circular disc, B. These screws, *a*, *a′*, are tipped with leather, and so little wear is there that those in the Dunsink observatory telescope have never been renewed since first put in, in 1853. The lower pivot rests in a cup attached to a slide acted upon by a cam, *f*, and wheel and sector, *g*, *h*. The shaft of this sector projects in front of the clock frame, where is attached an index arm and clamp pin playing round a circular divided arc. The clock is adjusted to sidereal rate by the screws, *a*, *a′*, which alter the working angles of the balls, and *b*, *b′*, which alter the length of the working conical pendulum, and this adjustment once made never requires alteration. Small differences as for planets are made by the arm working the sector and cam. For the moon there is, in another part, a set of differential wheels which make an alteration in speed from 25 to 26; this is the *mean of the extreme differences* between Sidereal and Lunar Rate. Actual lunar rate "pro tempore" is then obtained by final adjustment of the cam sector.

Fig. 11*a*.

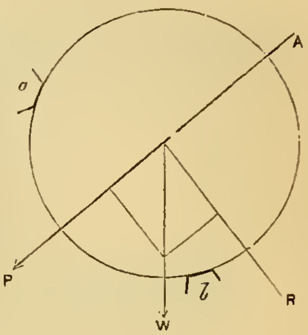


Fig. 12.

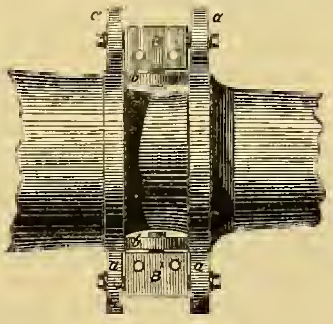


Fig. 13.

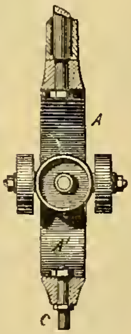
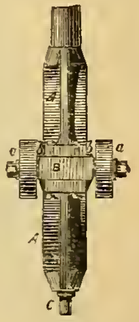


Fig. 14.



Figs. 12, 13, 14, 15, 16, and 17 (wood-cuts), are several views of the internal apparatus for the relief of the friction of the declination axis. The necessity of this apparatus in an instrument of such size supported in Y^s, and its method of working, are as follows:—

Suppose the diagram, 11*a*, to represent an end view of the declination axis *a* supported on Y^s at *a* and *b*; now it is evident in its present position nearly all the weight is supported on the Y *b*, while if the instrument be turned round *a* will perform a similar office. If therefore any force acting through the medium of friction rollers be applied in the mean direction, P A (the only feasible one), the instrument will roll out of its Y^s, and no good effect be produced. Resolve the force W acting perpendicularly into two, one, P, acting parallel to, and the other, R, at right angles to the polar axis. The first, P, inasmuch as it is parallel to and along the axis, is constant in its direction to that axis as it turns. The second, R, being at right angles, varies in its relative direction to that axis. If the force, R, could be disposed of, the instrument would be comparable to an alt-azimuth or equatorial at the pole of the earth, all the pressure being parallel to the axis; there would then be no difficulty in relieving the friction due to this.

Fig. 15.

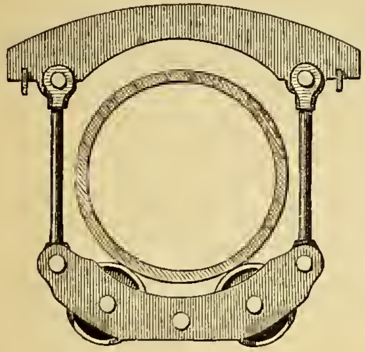
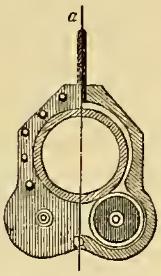


Fig. 17.



The apparatus, figs. 12, 13, 14, 15, is for the purpose of relieving as much as possible of the friction due to the force R. A pair of cast-steel semi rings, A A′, surround the declination axis at the point where its axis crosses that of tho polar, and where the declination axis is formed, as shown, fig. 13. Between the jaws of these rings are bolted a pair of gun-metal carriage frames, B B, carrying three rollers each; two, *a a*, working against two rings formed on the declination axis, and a third, *b*, working laterally in a groove, but not tightly fitted. The lower semi-ring has a steel stud, *c*, which enters into a cavity prepared for it at the bottom of the polar axis. The upper is prolonged by a long steel bar passing on through the upper end of the polar axis where it is acted upon by the sector and lever shown in fig. 2. This bar is stiffened by a hollow prism of cast iron put on while the steel bar was considerably heated, and tightened by a strong nut, *d*, fig 12. When sufficient upward force is applied to tho upper end of this bar by the sector and lever, fig. 2, this apparatus acting as a lever whose fulcrum is at the pier, *c*, raises the whole or any portion of the weight of the declination axis, telescope, counterpoises, &c., acting in the direction R, and that in a manner quite independent of the revolution of the polar axis. The remainder of the weight P is then, *but not till then*, capable of being relieved by the apparatus shown in succeeding figures.

Fig. 16.

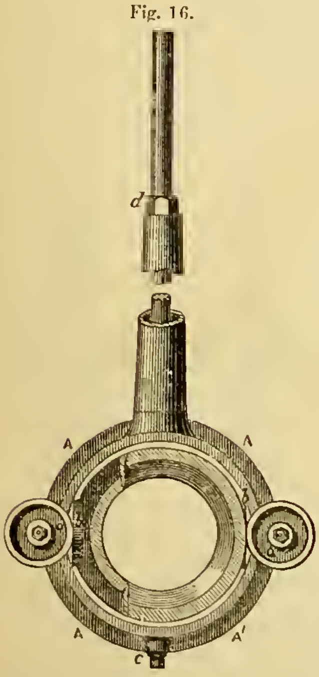


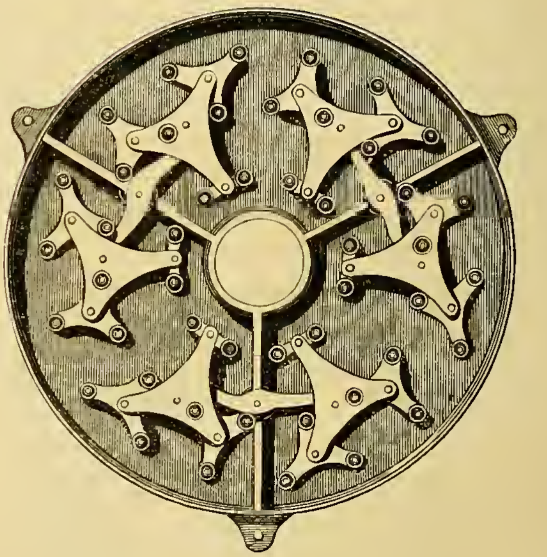
Fig. 16 is an elevation of the larger, and 17 a half elevation half section of the smaller, friction roller frame applied to the declination axis to relieve that portion of its weight acting parallel to the polar axis. The larger one is applied immediately in front of the larger (2 feet) bearing of the declination axis and behind the cradle. The smaller is applied immediately outside the smaller (1 foot) bearing of the declination axis. Both are connected by steel side levers and one cross line seen in general drawings centred on the cube of the polar axis. By the screwing up of the nut on the stud, *a*, fig. 17, of the smaller friction roller frame, any desired portion of the weight can be raised. The advantage of this very perfect system of anti-friction apparatus for the declination axis is, not only in the relief of friction, but in the opportunity it gives of having large bearings, and so of enormously increasing the steadiness of the instrument. The approximate weights of the moving parts are as follows:—

		Lbs.
Speculum in box,		3500
Tube 7 feet, boiler plate,	1300	
Tube 22 feet, lattice steel bars,	1370	2670
Polar axis,		3200
Declination axis,		1500
Cradle,		1100
Counterpoises,		4700
Small parts,		1500
		18,170

The force necessary to move the telescope of nearly 9 tons in right ascension is 5 lbs. at 20 feet, and in declination 12½ lbs. at 20 feet. Two persons, one at A quick motion and the other at declination quick motion, can reverse the instrument to opposite sides of the pier in 40″.

The circles are divided on an alloy of palladium and silver. The cutting of the teeth of the sector comprised six operations:—1, A set of divisions applied by an accurate cutting engine; 2, Corrections made by stepping microscopes, of the errors of these divisions, and their tabulation; 3, A second set of divisions put in when corrected according to table; 4, Teeth cut by several cutters, using microscopes and corrected divisions; 5, Teeth finished in shape by a hardened ratcheted screw; 6, A new screw applied with a corrected pitch of about $\frac{1}{300}$th apart.

Fig. 18.



It is well to mention that the anti-friction arrangement described for the declination axis, can only be applied to such telescopes as have their polar and declination axes balanced *inter se* round their point of intersection. Some telescopes have the counterpoises of the telescope hung from the opposite side of the polar axis, so that both axes are out of balance *in themselves*.

It remains to describe the mode in which the speculum (which for fear of accidents and to admit of observation and repolishing going on together has been sent out to Melbourne in duplicate) is supported in its frame in the telescope tube of boiler plate.

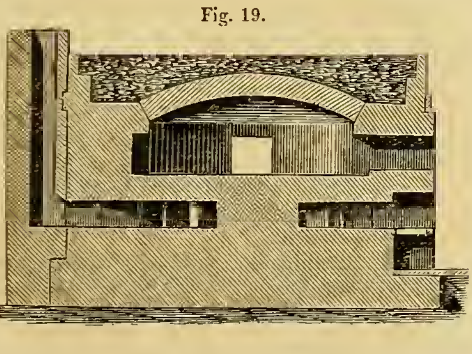
The most absolute freedom from restraint is necessary in effecting this, not only by reason of the extreme brittleness of the metal, consisting of 4 equivalents of copper and 1 of tin, or by weight, copper 32 + tin 14·77 lbs., but because unequal forces of a smallness that the outer world might scarcely credit are sufficient to destroy for the moment the figure of the speculum and the image of a celestial object reflected in it. It is a fact that the pressure of a single hand upon this huge disc of rigid metal, of 4 feet diameter and 4½ inches thickness and 1½ ton weight, blurs the image. M. Lassells hung his speculum in a loop of steel hoops by the edge, within the tube, and got over the difficulty of inverting the telescope in its equatorial mounting, by enabling the tube to revolve on its axis without carrying the speculum along with it; but this was attended with complication elsewhere. Mr Grubb's speculum is hung thus: A ring of L section is rivetted all round inside the tube at the proper place; into this engages a second T-shaped ring, which, as it were, hooks into the former all round, and this latter is prepared to receive the speculum itself round a belt cast on to it at its mid thickness, slightly projecting, and which, at the same time that the rough-cast speculum was ground flat at the back, was ground cylindrical by revolving blocks of gritstone; for it is to be remembered that steel tools will not touch this "speculum metal." This, therefore, is equivalent to a swinging or hanging endless hoop or loop, which acts alike in whatever position the telescope may be turned.

So much for lateral support; but the speculum must also, with a telescope mounted as this is, be supported at the back, *i.e.*, in line of the tube axis, and with absolute uniformity of support, as we have seen.

Let us suppose the flat disc of the speculum divided into three concentric imaginary zones or rings, each of equal weight, and imagine each of these rings cut up by radial planes again into *voussoirs*, all of which in all the rings, shall be of equal weight, so that there are 48 segments of equal weight, together making up the speculum. Now, if each of these is supported by a point at the back, beneath its centre of gravity (transverse to the plane of the disc), by a force equal to its own weight, the whole will remain *in statu quo*. But we may unite these segments three and three, or otherwise, and balance one against the other, or in triplets, by levers behind the speculum, so that the same *status in quo* shall prevail; and if this be done to the actual speculum, it results in the absence of any transverse strains from its supports.

This is just what is done. There are three imaginary zones: the imaginary equipollent *voussoirs* of the outer and next inner one are united in triplets by the three-cornered levers, as seen in fig. 18, a view of the back of the speculum; these again in triplets with those of the next zone within, and so on, until finally the back support of the speculum is reduced to three levers and three points. Each of these consists of a polished iron ball, placed with a little play between two cup-shaped cavities, one set attached to the last of the system of balancing levers, the others to the frame of the telescope tube. Within certain narrow limits, therefore, the heavy speculum is absolutely in every direction free; but beyond these it cannot pass, and within these narrow limits its bonds are so easy and glove-like, that tumble the huge tube about as we may, there is no fear of shake or "jog," or of any disturbance to the perfection of form once given to the speculum.

Fig. 19.

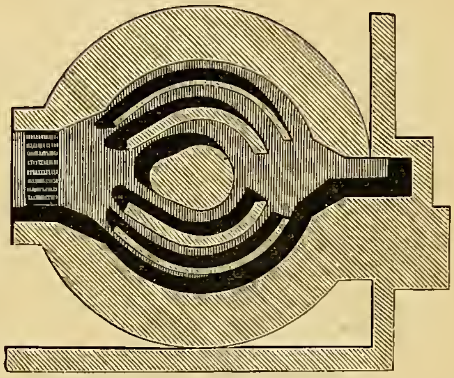


The speculum was in each case (three in all) cast upon the bed of hoops on edge, originally devised by Lord Rosse for his own telescopes, with certain modifications to suit the aperture here required through the centre by the Cassegrain construction, and with some improvements as to the management of the apparatus, due to Mr. Grubb. The metal was melted, the copper first, then the tin (with alloy previously made), with Irish turf fuel (and wood, we believe), in a reverberatory furnace, and the mould was of the nature of those called "open sand" or "open topped" by the founder; but here the bottom was of hoop iron wedged on edge tightly into a ring, the circumferential edge and centre cone alone being in dry sand. The mould lay upon a frame capable of being inclined or brought to level by a quadrant and endless screw beneath, and was begun to be filled first at one side, and as it filled was gradually tilted up level.

The metal was melted in cast-iron pots, which were lifted out with peculiarly-made tongs and crane tackle. This was a very delicate and touchy part of the apparatus, for the fusing point of cast iron, and in any case its temperature of brittleness and softness, are not far removed from the fusing point of speculum metal. But clay pots of this magnitude it was thought don't bear lifting when full, and wrought iron is found rapidly to alloy with and deteriorate the speculum metal. The pouring done and the metal "once set," the sand was removed from the centre hole and edges, and the whole, mould and all, removed into the annealing oven, previously heated to a good bright red. In this oven—the construction of which will be clear from fig. 19, which is a vertical section, and from figs. 20 and 21, which are sectional plans, and is very like some forms of coke oven—the speculum remained gradually cooling for more than a month, and when at last removed was not more than about 10° hotter than the outer air.

To enable the rate of cooling to be observed and its uniformity recorded, a thermo-electric couple of platinum and iron was inserted along with the speculum in the oven, and the diminishing amount of deflection of the galvanometer put outside within the circuit, gave the means of determining this.

Fig. 20.



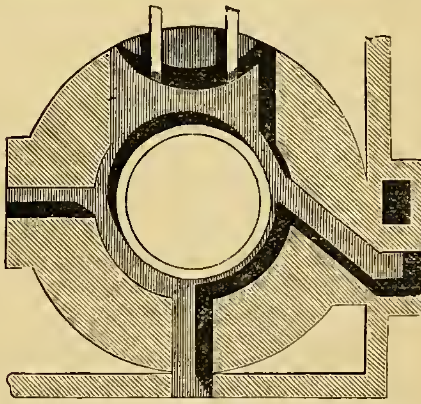
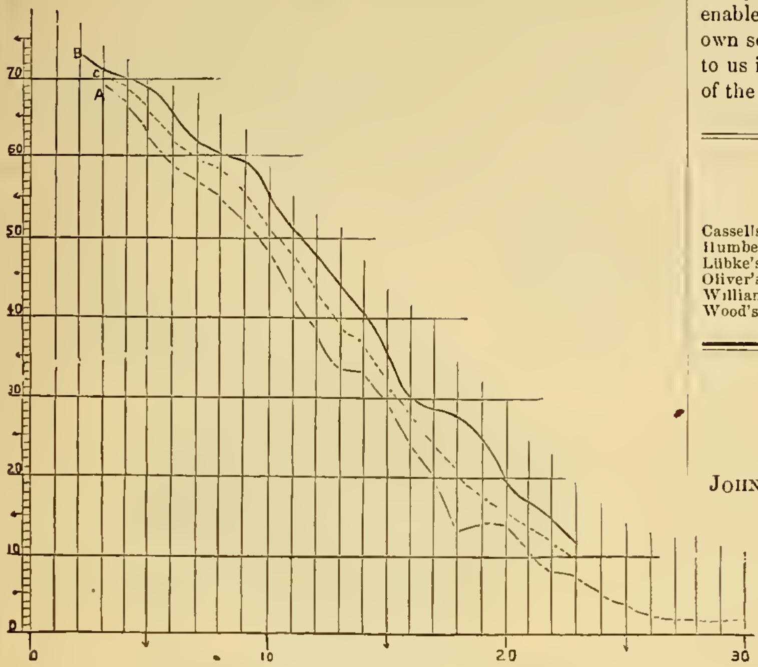


Fig. 21.

Fig. 22 shows the curves of descending temperature in relation to time, of the two specula, B and A, and the curve, C, between these, the mean rate of cooling, which it will be seen from this is almost uniform. The perturbations are curious, and would be found to connect themselves with the state of the wind, the external temperature, the shortening of the day, and so forth—all of which, as well as much besides, are functions in the final result of rate of cooling.

When withdrawn at last the rough speculum was trimmed with caution; ground, as already stated, at back and circumference; and at last laid upon the circular frame of the polishing machine, which is seen in fig. 23, Plate 11. This machine, which has upon it all the stamp of simplicity and perfection that characterizes whatever Grubb contrives, is greatly more simple and inexpensive, and greatly more convenient, than the ponderous machine employed by Lassells and by Nasmith. Figures of the latter, if we mistake not, will be found in Holtzapffell's "Mechanical Manipulation." The speculum slowly revolves while its disc is horizontal; above it works the polisher, which here is framed strongly but lightly of hard wood, and to it is given variable motions, not only transverse in orthogonal directions, but rotatory—so that a point in its face describes epitrochoids, or epicycloids, which are *not repetitive* or re-entrant. Diagrams of the curves describable by the machine are extremely curious. We cannot afford space to go into the details of polishing, its materials or methods. Those of our readers who are specially interested will before long have an opportunity of considering all these, from the elaborate paper by Mr. Grubb and Dr. Robinson now printing for the Philosophical Transactions.

Fig. 22.



One point we must notice. As polishing proceeds, it is always necessary from time to time to ascertain progress to figure by examination of the image of a test object. For this a rapid and convenient arrangement is here provided, so that the testing can be done without ever detaching the speculum from the machine or even handling it. The shallow cylindric saucer-like frame in which it lies—with all its balancing mattress of levers as described beneath it—is so fixed, along with its rotating shaft, &c., upon the frame of the machine, that by means of the quadrant and endless screw, seen in the figure, it can be turned in a few seconds from a horizontal position to a vertical one. The speculum then faces, at 800 feet away, a watch dial, or an "artificial star," as astronomers call a bright point, and the definition is then and thus observed through the central aperture, &c.: if not complete, the polishing is going on again within a minute or two.

Many details we are compelled for want of space to omit; in fact, to even approach doing justice to all parts of the instrument would require the whole of two or three parts of this Journal. Thus we are compelled to pass over the division of the hour circles, and the construction of the driving clock which carries the telescope *circum sidera pola*. Of this, all we can state is that so perfect is the controlling action of the centrifugal balls and friction governor. that under a crucial test of some hours' duration, it was found that whether the driving weight of the clock was 1·5, or 2·0, or 2·5, or 3·0 cwt., the rate of the clock was sensibly the same.

The photographic apparatus supplied to the instrument is on the plan of that so successfully employed by Mr. Warren de la Rue, and by which his wonderful photographs of our moon were produced Photographs of our satellite, which we owe to the kindness of Mr. Grubb, taken while the apparatus was yet in but a temporary state of completion, appear to us to exceed in definition and minuteness anything previously produced. As to the spectroscope belonging to the instrument, and as to the beautiful contrivances for *illuminating* the lines or "net" of the micrometer *upon a dark field*—a thing so important for the observation and measurement of nebulæ, we really cannot say anything now.

In another year—if, as all will fervently hope, no accident attend the transit or setting up of this grand telescope—the eye of the astronomer, aided by an adequate instrument, will be for the first time in the history of civilized man enabled to sweep and search the antarctic depths of the southern hemisphere. When we call to mind that scarce 250 years have yet elapsed since the first knowledge of the telescope enabled Galileo and others to discover the outlines of structure of our own solar system, what may we not expect within a few years, to come to us in the way of intelligence, from the infinite in space within range of the hemisphere in which blazes the southern cross.—Ed.

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RECENT PATENTS.

RAILWAY SIGNALS.

John A. Haswell, *of Gateshead, and* George Brown, *of York. Patent dated 3rd March*, 1868.

This invention relates to an apparatus to be worked by the action of the cord which establishes a communication between the guard or conductor, passengers, and engine-driver of railway passenger trains, and consists of a peculiar apparatus for exhibiting to the guard or conductor of a railway passenger train the particular compartment of a carriage containing the passenger who has, by means of the cord communication, called the attention of the guard, conductor, or driver to a real or imaginary danger to the train or to the passengers it contains, whilst it is in motion. In carrying out the invention it is proposed to place on the body of each carriage at the side of the top of the doorway or entrance of each compartment, a pulley for carrying the communicating cord, placed in a frame and supported in it by a helical spring, and a spindle passing through the said spring; the whole working in connection with a semaphore signal arm attached to the side of the doorway of each compartment.

The action of the apparatus is as follows:—When a passenger pulls the communicating cord downwards, the pressure on the pulley will compress the spring and the semaphore or arm signal will be released, and will project at right angles to the side of the carriage, exhibiting itself distinctly, and clearly indicating the compartment containing the passenger who has pulled the communicating cord, and will remain in such condition until released by the person or persons responsible for the proper working of the train.

This invention is obviously applicable to all railways on which passenger trains are run, where a communication exists between the guard or conductor and the engine driver by means of a cord. Each side of the carriage is fitted with the cord, but only one side is in gear at once. For convenience of attaching and detaching carriages at junctions and stations, each carriage has its own cords, which are joined by hooks with pointed openings, which hooks, when the ends are joined, cannot possibly shake open. One end of the cord is attached to the engine whistle by means of a helical spring, and the others to an adjusting wheel in the guard's van. This wheel to which the cord is attached gives out the cord when the train is extended on going round curves, and starting from stations, and takes up the slack cord. To this wheel is also fitted a ratchet wheel and a weight on pulleys, by which the cord is kept in a uniform state of tension. The weight can be adjusted so as to balance the friction on any length of train. A cross-bar is fixed on the rim of the coil wheel by a thumb screw, and kept on ordinary trains at about a quarter the circumference from the top. When the cord is pulled, either by the engine-driver or by a passenger, the cross-bar is brought to the top, and strikes the suspended lever of a bell which operates by clockwork. The guard and driver can exchange signals with facility which may be varied at pleasure, in so far as the number and length of sounds of the whistle or strokes of the bell are concerned.

Fig. 1.

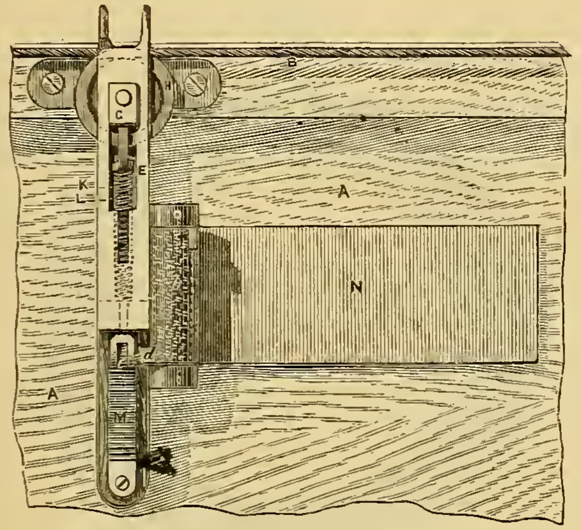


Fig. 2.

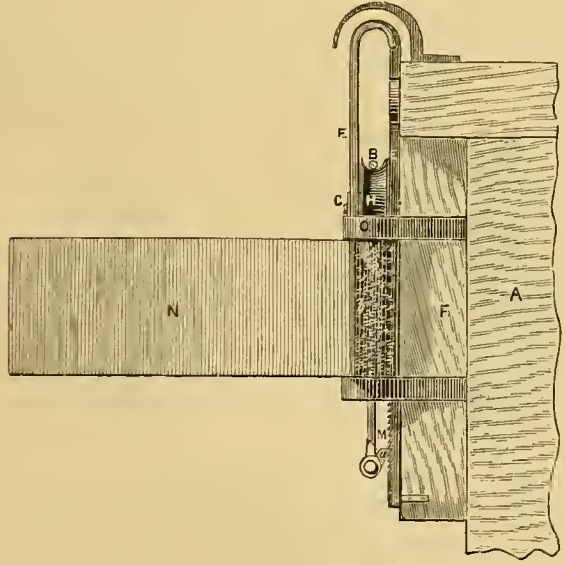


Fig. 1 of the engravings is a side elevation of the semaphore detector at rest, drawn to a large scale. Fig. 2 is a corresponding elevation looking at right angles to fig. 1, and showing the semaphore arm in its outward position at right angles to the side of the carriage, so as to indicate the compartment from which the cord has been pulled. In these several figs., A represents the carriage body, and B the communicating cord between the passengers and the guard and engine-driver, which cord is carried on each side of the carriage by passing over several fixed pulleys attached to the carriage close under the projecting roof thereof, so that the cords may clear the tops of the carriage doors. Each carriage is provided with a pair of these cords, and the several cords of the carriages throughout the entire length of the train are coupled together by spring hooks and eyes, or other convenient coupling. The semaphore detector signals, which are fitted to both sides of the carriages at the side of the tops of the doorways or entrances to each compartment, consist each of a slotted bracket, E, firmly secured to a wooden packing, F, attached to the carriage. Within the vertical slots of these brackets slide blocks, G, carrying each a grooved pulley, H, over which the communicating cord passes. To the lower part of each block, G, is screwed a rod or spindle, K, which is surrounded by a helical spring, L, of sufficient strength to maintain the block and pulley in their elevated position, the upper end of such spring bearing against the block, whilst its lower end rests upon the bottom of the bracket. The rod or spindle, K, is guided by passing through an opening in the lower part of the bracket, and carries a spring-hinged detent, *a*, which engages with the teeth of the straight rack, M, when pulled down, and prevents the pulley from resuming its original position until released by the guard. In fig. 2 the pulley is represented as having been pulled down and detained by the detent and rack. N is a semaphore arm working horizontally on the vertical axis, O, such arm being connected by a coiled spring, *b*, with the stationary axis, O. When not operating the semaphore lies flat against the side of the carriage as shown in fig. 1, it being detained in that position by a projecting pin, *c*, on the lower end of the rod or spindle, K, against which pin bears the lug, *d*, on the fulcrum end of the semaphore. So long as the pin, *c*, remains behind the lug, *d*, the semaphore will be held back against the side of the carriage; but immediately the pin, *c*, is lowered by the depression of the sliding block and pulley, H, the semaphore being released, flies out under the action of the spring, *b*, and assumes a position at right angles to the carriage, as shown in fig. 2. It will thus be seen that the pulling downwards of the communication cord with a view to calling the attention of the guard or driver, produces simultaneously three results; viz., the release of the semaphore arm or detector, which cannot be returned to its former position by the passengers (thereby indicating the particular part of the train whence the signal cord was pulled), the ringing or striking of the guard's bell or gong, and the sounding of the engine-whistle, or a gong or bell in close proximity to the engine-driver.

KILNS FOR DRYING BRICKS, LIME, AND CEMENT.

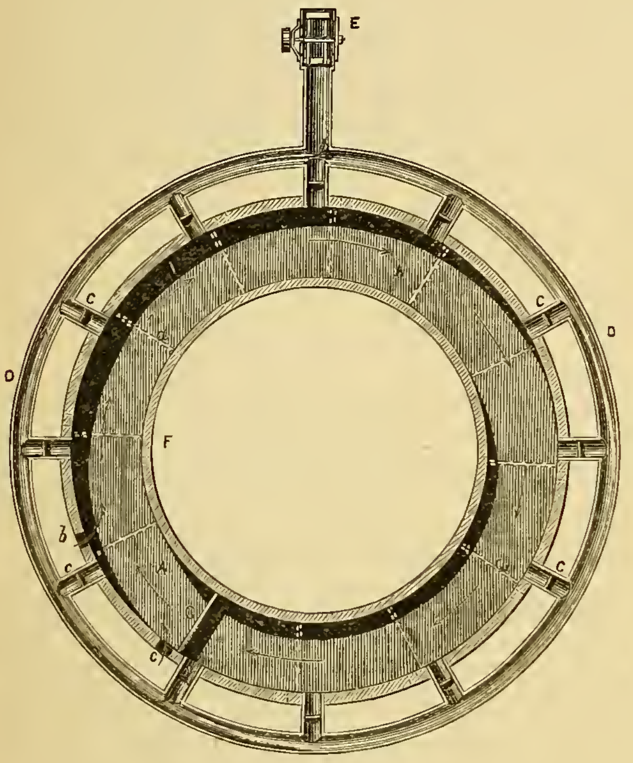
H. Chamberlain *and* J. Craven, *of Wakefield, and* H. Wedekind, *of London.—Patent dated* 19*th March*, 1868.

This invention relates, firstly, to certain modifications of, or improvements in, the kilns now generally known as Hoffman's continuous-action kilns, for burning bricks, lime, cement, and other like substances, for which letters patent were granted to Alfred Vincent Newton, bearing date the 22nd of December, 1859, No. 2918, and to Humphrey Chamberlain, John Craven, and Hermann Wedekind, bearing date the 24th of June, 1864, No. 1596; and has for its object the simplification of the construction of the said kilns, rendering them more suitable for contractors and temporary works, whilst, at the same time, as the steam and products of combustion are more rapidly carried off, a better quality of burned goods is obtained, and greater economy of fuel is effected. Secondly, to an improved mode of drying the bricks in the said kilns, whereby the colour of the bricks is much improved, and the construction of steam flues is dispensed with. Thirdly, to an improved appliance to be used in connection with the firing holes of the said kilns, with a view to preventing too great an inrush of cold air when there is a strong draught on, at the time the firing hole is opened for the introduction of fresh fuel, and to avoid the inconvenience which sometimes arises, when the draught is weak, from the internal pressure of gas and rarefied air causing a puff outwards through the firing hole, thereby losing heat and blowing away or scattering and wasting the small fuel as it is being introduced.

According to the first part of this invention, it is proposed to combine with kilns, constructed on the principles set forth in the specifications of the patents hereinbefore referred to, a system of forced combustion, obtained by the employment of a fan blower or exhauster situate on the outer or inner circumference, or on the top, of the burning chamber of the kiln, and dispensing with the use of the usual chimney and smoke chamber. In one modification a stationary fan communicates with a continuous flue, formed round the outer or inner circumference of the kiln, from which flue passages are formed connecting it with the divisions of the kiln, such passages being opened or closed by air-tight dampers in the order required. Air is either forced into the division containing the cooling bricks, or is exhausted from the division containing the green bricks; and in either case the draught is caused to circulate throughout the whole of the divisions, except those which are being either emptied or filled. In another modification it is proposed to use a portable fan, and dispense entirely with chimneys, flues, smoke chambers, and valves or dampers; the fan being simply connected direct with any one of the several divisions through the ordinary doorway, or through a special opening if preferred, and is to be removed from time to time to a fresh division as the fire proceeds. The air may either be forced in behind the fire, in which case it will pass off through a movable smoke pipe, temporarily fitted on to the feed holes or man holes, the position of this smoke pipe being changed as the fire proceeds; or the air may be exhausted from the front of the fire if preferred. The heat being wasted for the purpose of supporting the draught, as is the case with ordinary draught chimneys, it is obvious that a considerable saving of fuel in this respect will be effected. Should the air, as it leaves the kiln, be found to be of an elevated temperature, its heat may be utilized by being forced through separate drying chambers or flues.

In carrying out the second part of the invention there is placed a small fire grate over each or any desired number of the firing holes of the chamber of wet bricks, and a fire is kindled in each grate. The down draught into the kiln draws in a considerable quantity of heat at the numerous firing holes, and by having air holes beneath and surrounding the grate, cold air is admitted to mix with the hot air, and thus supports a continuous stream of warm, dry air through each fire hole down amongst the bricks, whereby they are effectually and rapidly dried off.

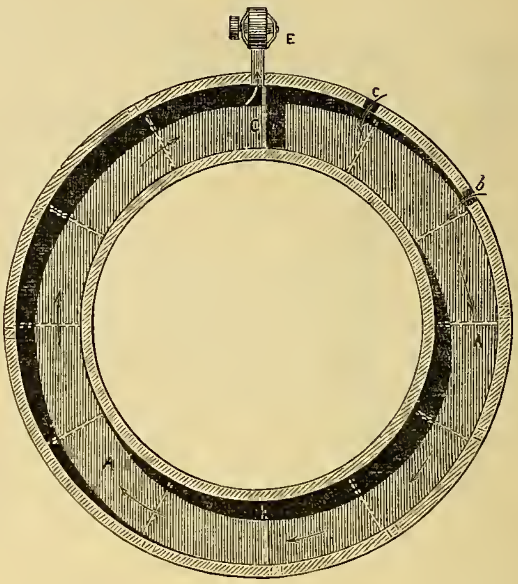
Fig. 1.



According to the third head of the invention, a removable metal or fire-clay cone or funnel mouth is employed, which has a contracted opening in the centre; and this cone is placed on each or any desired number of the feed pipes, in the section of the kiln which is burning. The contracted orifice prevents the disadvantages hereinbefore referred to, and when the section of the kiln is used for drying the green bricks, the cone may be readily removed to afford a larger inlet for the cold air which is required during the drying process.

Figs. 1 and 2 of the engravings represent sectional diagram plans, on a small scale, of a cheap construction of kiln intended to be worked on the continuous system, and specially adapted for the temporary use of contractors, or for erection on land containing only a thin seam of clay. In these modifications the construction of chimneys and smoke chambers is rendered unnecessary, a forced combustion being maintained by the aid either of an exhauster or blower. In fig. 1, A represents the continuous chamber of what is now generally known as Hoffman's kiln, which chamber is capable of being divided into compartments or sections, as in the Hoffman kiln, by movable transverse partitions, as shown by the radial dotted lines, *a a*. Each section of the annular chamber communicates by a branch passage or flue, C, either of brickwork or of metal, as shown in the engraving, with one common annular flue, D, also constructed either of brickwork or metal, leading to the exhaust fan, E, such fan being permanently connected with the flue, D. Although the flue, D, and fan, E, are shown on the outer side of the kiln, it is obvious that they may be disposed in the central or internal space, F, inclosed by the said annular or continuous chamber, in which case the branch flues, C, would open from the inner wall of the chamber. Each branch flue, C, is, of course, provided with a damper, in order to guide the draught in the proper direction. In the arrangement shown at fig. 2, all flues and dampers are dispensed with, as well as the chimney and smoke chamber. A is the annular kiln, and E is a portable exhaust fan, which is brought into connection with the different compartments or sections of the annular chamber as the burning proceeds.

Fig. 2.



It is preferred to make special openings in the side wall of the kiln for the introduction of the exhaust pipe, although, if desired, each of the doors leading into the kiln may have an opening made therein for that purpose. In both these figures G represents a closed partition, and arrows point out the direction of the draught. The fresh air enters by the openings, *b*, *c*, and after passing through the kiln or annular chamber, A, is drawn through the exhauster, E, along with the products of combustion in both arrangements. If the kiln be of small diameter, or the chamber, A, too short, to completely absorb the heat, arrangements can easily be made for causing the heated air to pass through separate drying chambers, or under a drying floor, if desired. In lieu of using a portable or movable exhauster, as shown in fig. 2, a movable blower may be similarly employed for forcing air into the kiln, the only difference in the mode of working being, that whereas in using an exhauster the connection should be formed at the last drying compartment, so as to draw the air entirely through the kiln or annular chamber, A, in the

Fig. 3.

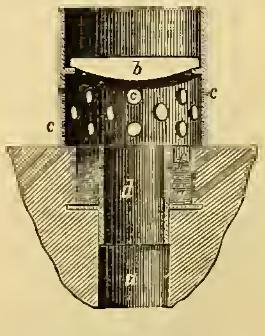
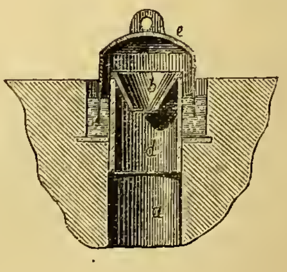


Fig. 4.



case of the blower the connection therewith should be made just in the rear of the firing section of the kiln, in order that the air may be forced through the cooling bricks and become heated on its way to the burning bricks. If desired the gases may be forced out through some of the firing holes or man holes in the roof of the chamber, A, into a chimney which is moved forward as the burning proceeds from one set of holes to another, or the said gases may be forced through a separate flue leading to one or more drying chambers for the drying of bricks or other substances. By reason of the superior control of the draught, which is obtained under the system of forced combustion above described, the steam may be more rapidly carried off, and consequently the colour of the burnt bricks will be improved. In the continuous-action kilns above described, it is obvious that the current of hot air may be properly guided or directed through the kiln by placing or stacking the bricks themselves in such a manner inside the annular chamber as to divert the draught at any desired place in the kiln; but it is preferred to use for that purpose temporary walls or movable partitions, G, as hereinbefore described. Fig. 3 represents a vertical section of a small fire grate, which it is proposed to place over each or any desired number of the firing holes in the roof of that part of the annular chamber of Hoffmann's kiln, wherein the wet bricks intended to be dried are deposited; *a* represents one of the firing holes in the roof situate above that portion or section of the kiln which for the time being contains wet bricks; *b* is the small fire grate which it is proposed to place over the opening, *a*, and in which a fire is kindled. The down draught into the kiln draws in with it through the firing holes, *a*, a considerable amount of heated air and gases at numerous points; and as cold air is admitted through side openings, *c*, *c*, below and surrounding the grate, *b*, it mixes with the hot air, and thus a series of currents of warm dry air enter through the roof of the kiln, and by circulating amongst the bricks, effect their rapid drying. Fig. 4 illustrates the third part of the invention, under which it is proposed to adapt to the top of each of the firing holes, *a*, in the kiln arch, a loose or removable cone or funnel, *b*, having a contracted mouth, which cone rests on the top of an iron feed pipe, *d*, fitted into the firing hole, *a*, as shown in figs. 3 and 4. As the mouth of this cone is contracted to about one inch only in diameter, it considerably diminishes the volume of cold air, which, when a strong draught is on, rushes down the firing hole, so soon as the lid or cover, *e*, is removed, thereby cooling the bricks, whilst, on the other hand, it serves to check the outward puff of gas and hot air which is liable to take place when, by reason of the draught being weak, a pressure of gas accumulates in the annular chamber of the kilns, thereby involving not only a loss of heat but a waste of fuel, and occasioning discomfort by causing the fuel to be blown up into the eyes of the stoker, as will sometimes occur if the full size of the firing hole (which is about six inches in diameter) be retained. As these firing holes, however, sometimes require to be used as air inlets, as, for example, when they happen to be situate over that section of the kiln wherein the bricks are drying, they cannot be permanently contracted, since it is requisite that the full size of orifice be then used to afford free ingress of air with a view to the more effectual drying of the bricks. As the cones, *b*, however, are loose, they may be readily removed when the holes, *a*, are required solely as air inlets into the section containing fresh bricks. During the intervals of stoking or supplying fuel the firing holes with their cones are kept closed by the cap or cover, *e*, which is maintained air-tight, or nearly so, by the said joint, *f*. Hitherto reduced or powdered coal has been employed as the most suitable fuel with which to supply kilns constructed and used on what is known as Hoffmann's system; but it is proposed, where circumstances will permit, to employ liquid fuel in lieu of coal, such liquid fuel consisting of any of the liquid hydrocarbons capable of being burned as fuel. This liquid fuel is introduced through the firing holes, *a*, in the arch of the continuous chamber, drop by drop, from reservoirs suitably placed for the purpose.

LAW REPORT.

Kerr *v.* Clark & Co.—The pursuer in this action, as previously mentioned in this journal, was Mr. Peter Kerr, of the firm of Messrs. J. & J. Clark & Co., thread manufacturers, Seedhills, &c., Paisley, and the defenders Messrs. J. Clark & Co., thread manufacturers, Gordon's Loan, Paisley, and Mr. John Clark, the only known partner of that firm. The action was raised for the purpose of recovering damages for infringement and for interdict against the future infringement of letters patent, obtained by the pursuer on 2nd October, 1857, for the invention of "Improvements in Preparing and Finishing Threads and Yarns," and the defenders in their defences assailed the validity of the letters patent, in respect (1) That the specification and drawings did not embrace or contain any subject matter which could legally be made the subject of a patent; (2) That the pursuer was not the true and first inventor of the said invention; (3) That the invention was publicly known and used at and prior to the date of the letters patent; (4) That the invention was not sufficiently or intelligibly described or explained, so as to enable a workman of ordinary skill to put it into practice; (5) That the machinery or apparatus described did not display any ingenuity or invention, and were of no use or public utility, and did not accomplish the ends or objects which they professed to serve; (6) That the pursuer, in the specification and drawings, did not sufficiently distinguish between what was old and not claimed by him, and what was new and claimed by him; and (7) That the improvements as alleged were not inventions within the meaning of the letters patent, or of the statutes authorizing the granting of letters patent. The defenders also denied that they were infringing the pursuer's letters patent. In support of the second plea the defenders alleged that inventions substantially the same as the pursuer's were described and disclosed in letters patent granted to Godfrey Ermen, cotton-spinner and manufacturer, Manchester, dated 22nd October. 1856, and to Charles Brook, the younger, manufacturer, Meltham Mills, near Huddersfield, dated 9th September, 1856, which were chiefly relied upon, and in other five letters patent condescended on; and in support of the third plea. they alleged that inventions or machinery and apparatus and systems or modes of polishing or finishing threads or yarns, substantially the same as the pursuer's, were, prior to the date of the letters patent, publicly made or used by twenty-three different persons or firms of thread manufacturers and others therein named.

The case was tried before the Lord President and a Jury, at the sittings in July, upon the following issue and counter issues:—"It being admitted that the pursuer obtained the letters patent No. 9 of process, dated 2nd October, 1857, and sealed 5th January, 1858, and duly filed, the specification of which No. 14 of process is a certified copy, and relative drawings of which No. 15 of process is a certified copy; and it being further admitted that, on 16th July, 1864, the pursuer duly executed, and thereafter, on 18th August, 1864, duly filed, a disclaimer and memorandum of alteration upon the said specifications, of which No. 16 of process is a certified copy."

"Whether, from the 20th April, 1867, to the 14th November, 1867, or during part of said period, and during the currency of the said letters patent, the defenders did, at their works at Paisley, wrongfully, and in contravention of the said letters patent, use the invention described in the said letters patent, specification, and relative drawings, as altered by the said disclaimer and memorandum of alteration, or a material part of the said invention, to the loss, injury, and damage of the pursuer?"

Or,

"1. Whether the pursuer is not the first and true inventor of the invention described in the said letters patent and relative specification and drawings and disclaimer?

"2. Whether the invention described in the said letters patent and relative specification and drawings and disclaimer was publicly used in the United Kingdom prior to the date of the said letters patent?"

Damages laid at £500.

After a protracted trial which occupied four days, during which the defenders gave up their plea of prior use, and raised for the first time an objection to the effect that there was a discrepancy between the title of the letters patent and the substance of the specification, the jury returned a verdict for the pursuer on all the issues, and assessed the damages at £50, reserving to the defenders leave to move the court to enter up the verdict for them in the event of the court being of opinion that the patent was invalid on the ground of any legal objection that might be competently urged by the defenders. The verdict was published in this journal at the time, and need not be again quoted.

At the opening of the present session, the defenders moved the court to set aside the verdict as contrary to evidence, and they alternately moved that the verdict should be entered up for them in respect the reserved questions of law fell to be decided in their favour; and, upon the 27th and 28th October, counsel for both parties were heard on the whole case, and on Wednesday, the 4th ult., the case was finally decided in favour of the pursuer.

At advising,

Lord President—This case was sent to trial on three issues—the pursuer's ordinary issue of infringement, and the two counter issues for the defenders, the former of which challenged the originality of the invention claimed by the pursuer, and the latter was an issue of prior use. These issues were framed in accordance with the well-established styles appropriate to patent cases. The cause was tried before me at the last jury sittings of this division of the court. It appeared in the course of the trial that questions of law of nicety and importance would necessarily arise affecting the validity of the patent, and it was my earnest endeavour—in which I was much assisted by the counsel for the parties—to put the case in such a shape as would enable the court to decide these questions of law without much, if any, risk of a new trial The verdict accordingly assumed the form in which it now appears. It embodies the conclusions of the jury on every question of fact which appeared to me to arise on the issues, or to require to be determined as the basis of a judgment on the questions of law; and these questions of law affecting the validity of the patent are by the verdict reserved for the court in a form which, I think, will be found to be safe and convenient. If the verdict is not disturbed as being in any respect against evidence, the court are in a position to decide the whole cause, and to appoint the verdict to be entered up either for the pursuer or for the defenders, according to the opinion they form on the question of law reserved. In the first place, however, we must consider whether the verdict is assailable, as being in any respect against evidence It finds for the pursuer on the first counter issue, "Whether the pursuer is not the first and true inventor," &c.; and it finds for the pursuer, of consent of the defenders, on the second counter issue, that of prior use. It also finds for the pursuer on the pursuer's issue of infringement, but subject to the reservation of the legal objections to the patent. Now, the defenders challenge the finding of the jury on the pursuer's issue, and on the first counter issue, as being against evidence, and on this ground they ask for a new trial. They maintain that the weight of the evidence was against the originality of the pursuer's invention, and that the jury ought to have been satisfied, and ought to have found that the invention was not new. On this question I think the verdict is sound, and justified by the evidence, the true import and result of which appeared to me at the trial, and appears to me now, to be that the polisher introduced by the pursuer is essentially different from any previously known, and that its construction and application to the polishing of thread was a useful novelty in this department of manufacturing industry. It would be a mere waste of time to analyze the evidence, or to point out, as I think was successfully done by the counsel for the pursuer, the material differences between the pursuer's polisber and the others witb which it was compared.

But besides that part of the verdict to which I have as yet adverted, the jury at my request returned certain special findings, for the purpose of furnishing the court with all the facts necessary to enable them to decide the questions of law reserved; and the defenders challenge two of these special findings as being against evidence. One of tbe findings so challenged is in these terms:—"Find that polishing threads or yarns by frictional contact with rollers or cylinders revolving on their own axis, in which grooves or annular indentations are made for the purpose of smoothing or polishing the said threads or yarns, was new at the date of tbe pursuer's patent" Now, it is true that frictional contact with rollers or cylinders moving on their own axis was a known method of polishing thread before the patent. It is also true that one ingenious inventor recommended that of three such rollers whicb he used one should be grooved, while the other two were left smooth and ungrooved on their surfaces; but the grooving of this one roller was for the purpose of guiding the threads in their passage, and not for the purpose of smoothing or polishing the threads, as expressed in tbe finding. Again, the defenders contend that the following special finding is against evidence:—"Find the system or mode of constructing frictional polishers, in which a current of air is made to pass through the shafts thereof, and to impinge on tbe threads or yarns by means of fanner blades or vanes, was new at the date of the pursuer's patent." Here, again, I think the finding is perfectly justified by the state of the evidence, as there was no proof of the previous publication or disclosure of such an arrangement as is described in the finding. I am therefore of opinion that, as the first step towards the disposal of this cause, we should refuse the defenders' motion for a rule to show cause why the verdict should not be set aside as contrary to evidence.

We proceed, then, to the consideration of the legal objections to the patent raised by the defenders with these propositions finally established by the verdict —first, that the pursuer's invention, protected by the patent, consists in the construction of the polisher described in the specification, and in its application to the polishing of thread; second, that this invention is new and useful; and, third, that the defenders have used the invention without the pursuer's license, during the currency of the patent. But assuming all this to be clear, the defenders contend that the patent is invalid on two separate and distinct grounds—first, that there is a material discrepancy between the title and the specification; or, in other words, that the patentee has failed to disclose and explain in his specification the whole of the invention or inventions for which the patent was granted; and, second, that a part or parts of what the specification claims as new is not new, and has been found by the verdict to be not new. These are both of them formidable objections, and require careful consideration. First, the title of the patent is "Improvements in Preparing and Finishing Threads or Yarns." In the specification the only inventiou claimed is the construction of a new polisher and its application to the polishing of thread. The defenders contend that this may be an improvement in the finishing, which is synonymous with the polishing of threads or yarns, but is not an improvement in the preparing of threads or yarns, for "preparing," they say, is a word of technical signification in the thread manufacturing trade, and means the immersion of the thread in starch, size, or some other solution, as a necessary preparation for the process of polishing; or, as the jury have specially found, "the term 'preparing thread,' used in the title of the patent, means, in the language of tho thread manufacturing trade, the starching or sizing of the thread previous to its being polished, and means nothing else." The first answer which the pursuer makes to this objection is, that there is no notice of it in the record; and, therefore, it could not be competently stated at the trial, and cannot be competently stated now as a ground for entering up the verdict for the defenders If the objection could not be competently stated at the trial, I am of opinion that it cannot be competently stated now, for the leave reserved to the defenders by the verdict is to move to enter up the verdict for them on the ground of any legal objection or objections that may be competently urged by the defenders. Indeed, it was not disputed by the defenders in argument tbat the reservation as thus expressed was intended to reserve entire, not only their legal objections, but all the answers which the pursuer could make to these objections when they arose in the course of the trial. The preliminary question, therefore, comes to be whether the defenders could competently raise this objection at the trial, or whether they were precluded from doing so from want of notice on the record? Now, I hold it to be quite established in the practice both of England and Scotland, in patent cases, that in an action for infringement of a patent, the defender is not allowed at the trial to maintain any objection to the patent of which he has not given notice to the pursuer. In England, previous notice of objections is secured by the 5th section of the Act 5 and 6 William IV., cap. 83, and that particular section bas been held not to apply to Scotland; while other sections of the Act do apply, solely because by tbe form of our records framed under tbe provisions of the Judicature Act, 6 George IV., cap. 120, the same security is provided. This was decided in the case of the *Househill Company v. Nelson* (2 Bells, App. p. 1). A distinction, however, might be drawn between such objections as depend in any degree for their effect on fact and evidence, and tbose which arise purely on the construction of the patent and specification. The latter class may sometimes be covered by a plea in law, expressed in somewhat general terms, or may, perhaps, even lurk under a plea stated originally for a different purpose. But in the former class of objections, the inquiry whether there is sufficient notice will depend mainly on whether the fact on which the objection depends is sufficiently averred in the defenders' statement of facts. Now, it appears to me that there can be no difficulty in determining to which of these classes the present objection belongs. Reading the patent and specification without any extraneous light, there is no apparent discrepancy. Preparing and finishing thread may very fairly be supposed, by the uninformed judicial mind, to be the process of polishing, and nothing else; and it is in the process of polishing that the pursuer has introduced his patented improvement in the shape of a new polisher. It is only when the court comes to be informed, by evidence or by the finding of the jury, that "preparing" is a technical term, and means starching or sizing, and nothing else, in the thread manufacturing trade, that the objection of discrepancy of the title and specification becomes intelligible. The defenders contend that their fourth plea in law sufficiently covers this objection to the patent, because they there object that the inventions are not sufficiently or intelligibly explained, and so as to enable a workman of ordinary skill to put the alleged inventions into practice. I greatly doubt whetber tbis plea covers the objection, even if tbere were no defect of averment of fact, to which I shall immediately advert. This plea can be applicable to the specification only, for the specification is the only instrument in which the patentee is under any obligation to describe or explain, and this is made still more clear by the reference to the understanding of a workman of ordinary skill; for it is the special office of the specification to disclose the invention in such a way as to be intelligible to a person of that class. Now, intelligibility to a workman of ordinary skill is a fault in the specification which, in the practice of patent law, falls to be disposed of by the jury, and not by the court. It would, therefore, be very difficult to bring the objection to the patent, on the ground of discrepancy of title and specification, within the words of this plea. But it is of less consequence to dwell upon this consideration, because the objection is clearly not maintainable for want of averment of fact. There is not in the defenders' statement of facts on record one sentence or one word bearing on this objection, and yet the whole force and effect of the objection depends on the fact that "preparing" in this trade has a technical signification, as found by the verdict. It appears to me that the strict practice of the courts of England, as well as of Scotland, in patent cases, to which I have referred, is founded on reasons of undoubted justice and expediency. There is no class of cases in which it is so desirable, nay, so indispensable to the right administration of justice to prevent surprise at the trial, and no better illustration can be given of the importance of the practice than occurred in the trial of this case. Unquestionably the pursuer was entirely taken by surprise when this objection was raised, and had no opportunity of showing, or attempting to show, that in the thread manufacturing trade tbe word "preparing" may be used in different senses, or that its meaning may depend, in the understanding of that trade, upon whether it is used in connection with other words and phrases, or of meeting in any other way the evidence led on this point by the defenders. I am therefore of opinion that the objection to the discrepancy of the title and specification cannot competently be raised by the defenders, and I find myself thus at once relieved and precluded from considering that objection on its merits.

The defenders' second objection to the patent falling within the reservation in the verdict is that, assuming there is novelty of invention to support a patent, tbe pursuer has in his specification claimed some thing or things that are not new, and consequently that the whole patent is void. If the claim of the patentee includes what is not new, and is not of his invention, the objection will no doubt be fatal, though the patent and specification may embrace also what is new, useful, and meritorious. This objection is founded on two special findings in the verdict. The first of these is, "That the system or mode of polishing or finishing threads or yarns by means of a pair of frictional polishers was not new at the date of the pursuer's patent;" and the second is, "That the system or mode of polishing or finishing threads or yarns by means of a single frictional polisher, roller, or cylinder, was not new at the date of the pursuer's patent." Tbese findings, it is needless to say, were quite justified by the evidence; and it is equally clear tbat they could not impeach in any degree the originality of the pursuer's invention, as it has been defined by the jury, namely, the construction of a new kind of polisber, and its application to the polishing of thread, for the novelty of the pursuer's polisher consists, not in its being a frictional polisher, but in its having its polishing surface grooved with annular or transverse grooves, in which the threads are received, and polished by means of contact witb the smooth surface within the grooves. But the weight of the objection depends upon the defenders' criticism on and construction of the 3rd and 4th heads of the claim with which the specification closes. The five different heads of the claim are introduced by a disclaiming sentence, as follows:—"I, however, make no claim to any of the mechanical parts separately, nor to any combination thereof, when sucb polishers as are herein described and shown are not used; but what I consider to be novel and original, and therefore claim," &c., is, 1st, "The general arrangement and construction of the polisher; 2nd, The arrangement and construction of polishing apparatus, in wbich the threads or yarns are polished by frictional contact with bars or rods, or simple rollers or cylinders, in which grooves or annular indentations are made for the purpose of smoothing and polishing the said threads or yarns, as hereinbefore described; 3rd, The system or mode of polishing or finishing threads or yarns by means of a pair of grooved frictional polishers, as hereinbefore described; 4th, The system or mode of polishing or finishing threads or yarns by means of a single grooved frictional polisher, roller, or cylinder, as hereinbefore described." Now, the objection under consideration must depend upon the answer to the question whether the special findings of the jury, above quoted, negative the originality of that which is claimed in the 3rd and 4th heads; and I cannot but tbink that both the 3rd and 4th heads of the claim are awkwardly and most unhappily expressed in claiming a system or mode, while the invention is clearly of an apparatus or piece of mechanism; but this is not of itself fatal. The mere use of these inappropriate words must not be allowed to interfere with the true and fair meaning of the sentences in which they occur. I am of opinion tbat the patentee, in using the phrase in tbe 3rd head, "The system or mode of polishing or finishing threads by means of a pair of grooved frictional polishers, as hereinbefore described," meant to claim no more, and has not in fair construction claimed more, than the polishing or finishing of thread by means of the grooved frictional polishers, which he has already so carefully described; and the same construction equally applies to the 4th head of the claim. When these heads are so construed, the novelty of the claims which they embody is not at all affected by the finding of the jury, for these negative the novelty only of the use of a pair of frictional polishers, or of a single frictional polisher, for the polishing or finishing of threads; while the essence of the 3rd and 4th heads of the claim is, polishing by means of the new and peculiar polisher described in the specification. I am, therefore, of opinion that the second legal objection to the validity of the patent, taken by the defenders, is not well founded on its merits.

The questions of law reserved being thus decided favourably for the pursuer, the result is, that the verdict ought to be entered up as a verdict for him, and that he should have decree for the sum of damages found by the jury, and also judgment in terms of the prohibitory conclusions of the summons.

Lord Deas—I have carefully read and considered all the evidence in this case, and I have likewise considered, as carefully as I could, the arguments submitted to us for both sides upon the legal questions involved in it; and I have arrived at a conclusion upon all these matters, so substantially the same with what has been stated by your lordship, that I think it quite unnecessary to enlarge upon the subject. I agree in opinion with your lordship, that it is impossible for us to say that there are any findings, in point of fact, in this verdict so different from what the proof authorizes, as to entitle us to interfere with the verdict, upon the ground that it is against evidence. On the contrary, I am disposed to think that these findings are quite consistent with the evidence. More particularly as to the novelty and utility of the invention, I entirely go along with the verdict of the jury and the opinion of your lordship. Then, there are two legal objections pressed upon us, to which your lordship has alluded. In the first place, objection is taken on the ground of discrepancy between the title of the patent and the specification, the title being, "Improvements in preparing and finishing threads or yarns." That difficulty is made formidable by the finding of the jury, to the effect that the term "preparing" thread, used in the title, means in the language of the thread manufacturing trade the starching or sizing of the thread previous to its being polished, and means nothing else. That, as I understand it, and as I understood the counsel on both sides to agree, means that it has no other trade meaning. Now, I am entirely of the opinion expressed by your lordship, that it was most important for the ends of justice here that the patentee should be made aware before the trial that this objection was to be pleaded against him. It raises, as your lordship has pointed out, an objection of not merely want of notice of the law, which was to be pleaded, but want of notice of a matter of fact which was to be pleaded, namely, that it was intended to be proved by witnesses that the words "preparing thread," had a particular trade meaning—that is to say, starching or sizing the thread before being polished, and had no other trade meaning. I do not impugn the finding of the jury upon that matter, any more than your lordship does upon the evidence which was before them; but the question then is, whether, if the patentee had had fair notice that that was the meaning which they meant to attach to it, and to prove by witnesses ought to be attached to it, he might not have proved either that that was not the proper meaning, or, at all events, that it was not the only meaning which was so attached to it? And not only so, but he was entitled to have the opportunity of bringing evidence to show that, although when used in a certain way, and with a certain reference in the trade, it had that meaning, yet that that was not an exclusive meaning—that it was not understood even in the trade that that was the exclusive meaning; but that workmen reading this, might quite well understand that it was not confined to that meaning in this title or in this specification. If he had had notice, he might have brought proof about all that, and then the question would have been what the effect of that proof was —a question which, as things stand, neither the jury nor the court have the proper data or means of considering. Now, looking upon it in that light, I do not think it necessary, any more than your lordship does, to form or to express an opinion as to what the effect of this alleged discrepancy might have been if there had been due notice of the objection, and an opportunity to the patentee to adduce his proof upon that matter as well as upon the other parts of the case. If there had been that notice the question would have been fairly raised, whether ordinary workmen or other persons reading that title and reading along with it this specification could reasonably be supposed to be misled by the use of that word, or whether it was not sufficiently clear that the word was used in a sense which did not interfere with the legal effect of the patent.

As to the second objection, that the patentee claims certain things which are not new, I agree with your lordship that some of the phraseology in this specification is not happily chosen, and that more particularly these words, in the 3rd and 4th heads, and also in the 5th head, "system or mode of polishing or finishing," and so on, are words which are not particularly appropriate to express the meaning which they were meant to bear; but, at the same time, I cannot say that, reading that specification fairly, there is any dubiety on my mind as to what is meant. In an earlier part of the patent, in the disclaimer, the patentee says—"My said invention relates to machinery or apparatus to be used," so and so. Now, I think that over-rides the whole, and you will find that the meaning throughout is that what his patent relates to is machinery or apparatus; and consequently when he says under these heads that he claims the system or mode of polishing and finishing threads or yarns, so and so, as hereinbefore described, I think the fair meaning of that is, that he claims these things by machinery or apparatus, which is the system or mode—although that is not a very good word to express it—which he had previously set forth. I think there is nothing claimed throughout but that which is to be done by the machinery or apparatus which he describes. I therefore concur with your lordship, that this objection also cannot be given effect to.

My opinion upon the whole matter has been so fully expressed by your lordship, that I do not think it necessary to say more on any part of this case.

Lord Kinloch—I concur in the result arrived at by both of your lordships. I have carefully considered the evidence in this case, and I cannot come to the conclusion that, on any of the points found by the jury, the verdict is against evidence. On the leading point of the case, the inference which I draw from the proof is, that whatever similarity may exist in particular parts of the apparatus to portions of other machines, the combination effected by the pursuer for the particular purpose in view is new and of the pursuer's invention, and entitled, unless other valid objections lie against it, to the privilege of a patent.

There then arise for consideration the legal objections stated against the patent, which are substantially two. The first of these is rested on an alleged disconformity between the title of the patent and the specification. The title of the patent points to the invention of improvements in preparing and finishing threads or yarns, while the specification contains, as alleged, no description of any improvement in "preparing threads or yarns" according to the trade meaning of the word "preparing," which the verdict of the jury finds is the starching or sizing of the thread previous to its being polished, and nothing else. This objection considered in itself is one of considerable interest and difficulty; but I concur in thinking that all judicial consideration of the objection is precluded by want of notice, and in this view I am not called on, nor in the strict judicial sense entitled, to pronounce any judgment on the objection. I am very clearly of opinion that all legal objections to a patent require to be distinctly set forth in the record; and this both in respect of the legal plea and of any special fact on which it is rested. It is thus that, according to the peculiarities of our Scotch form of process, we enforce, in favour of patentees, that protection against surprise at the trial which in English practice is effected by a separate notice of objections; and which is in itself so reasonable, indeed, so manifestly essential to justice and fair dealing. In the present case the objection is rested on the assumed fact that the word "preparing" bears in the trade of thread manufacturing a special and peculiar meaning, different from that attached to it in ordinary language, and is restricted exclusively to the starching or sizing of the thread previous to its being polished; the facts so assumed being, I conceive, essential to the validity of the objection, for if the word "preparing" is to have given to it its general meaning of making ready for the market, there is no disconformity traceable between the patent and the specification. The disconformity arises out of the meaning borne by the word "preparing" which lies behind the documents, and is not apparent on their face. I am of opinion that any meaning different from the common, borne by the word in the usage of this particular trade, if intended to be relied on, ought to have been set forth as a special fact on record; and I further think that the objection founded on the fact ought to have been the subject of a separate and special plea in law. The fact is admittedly not set forth, and I think the plea in law is neither separately stated, nor can be held to be so embraced in any of the other pleas as to meet the legal requirement. I am therefore of opinion that the defenders are now barred from pleading or asking judgment on this objection.

The other legal objection is that, in the 3rd and 4th items of the claim contained in the specification, the pursuer claims as an invention what the jury have found to be not new. There cannot be any doubt of the principle in patent law, that if any portion of what is claimed as an invention be in point of fact not new, the whole patent is void; but I am of opinion here that, according to a just construction of the specification, the pursuer has not made such a claim. What the jury have found to be not new is, first, the system or mode of polishing or finishing threads or yarns by means of a pair of frictional polishers; and, secondly, the system or mode of polishing or finishing threads or yarns by means of a single frictional polisher, roller, or cylinder. Now, the pursuer does not claim, as his invention, the mode of polishing threads either by a pair of frictional polishers or by a single frictional polisher, roller, or cylinder, abstractedly considered. It is in either case by a grooved polisher, roller, or cylinder; the grooves on the instrument polishing being an essential part of the invention. Further, he claims the system or mode "as hereinbefore described," thereby referring back to the description of the apparatus previously given; and he prefaces his claim by declaring, "I make no claim to any of the mechanical parts separately, nor to any combination thereof, when such polishers as are herein described and shown are not used." I am of opinion that, in these combined statements, the pursuer only claims as his invention the grooved polisher or cylinder previously described, and the grooved polisher or cylinder as fitted and applied in the way set forth. I conceive him not to claim as his invention, but directly the contrary, the use of a pair of frictional polishers, or of a single frictional polisher, roller, or cylinder, apart from the grooved construction of these polishers, and their adaptation and application in the way previously described. I am, therefore, of opinion that this objection is unfounded.

The court pronounced the following interlocutors:—

Edinburgh, 4th November, 1868. The Lords, having heard counsel on the defenders' motion for a rule to show cause why the verdict should not be set aside and a new trial granted, refuse the rule.

(Signed) John Inglis, J.P.D.

Edinburgh, 4th November, 1868. The Lords, having heard counsel on the motion of the pursuer to enter up a verdict for him and decern in terms of the conclusions of the summons, and also on the defenders' motion in pursuance of leave, reserved by the verdict, to enter up the verdict for them on the ground of legal objections to the validity of the patent, enter up the verdict for the pursuer, and in respect thereof decern against the defenders to make payment of fifty pounds of damages to the pursuer. Further, interdict, prohibit, and discharge the defenders in terms of the prohibitory conclusions of the summons and decern. Find the pursuer entitled to expenses; allow an account to be given in, and remit the same when lodged to the auditor of court to tax and to report.

(Signed) John Inglis, J.P.D.

Counsel for the Pursuer—Mr. Clark and Mr. Balfour. Agents—Messrs. Gibson, Craig, Dalziel, and Brodies, W.S., Edinburgh; and Messrs. Hodge, Young, & Martin, writers in Paisley.

Counsel for the Defenders—Mr. Young, and Mr. Gifford. Agents—Messrs. Campbell & Smith, S.S.C., Edinburgh; and Messrs. Campbell & Russell, writers, Paisley.

REVIEWS OF NEW BOOKS.

On Ascertaining the Intensity of Storms by the Calculation of Barometric Gradients. By Thomas Stevenson, F.R.S.E., C.E.

This is an extract from a paper read by Mr. Stevenson before the Scottish Meteorological Society, and is of considerable interest and importance. As all winds and storms arise from inequality of barometric pressure at different spots of the earth's surface, no matter at present from what causes these inequalities arise, and as the force urging the wind laterally from the place of the column of greater barometric pressure to that of the smaller, is the propelling wind force, and is directly proportionate to the differences between the higher and the lower columns, while the retarding forces are proportionate to the distances that have to be traversed by the wind laterally from the one place to the other; so it follows that the intensity of the moving force, or what is the same thing, the velocity of the wind at an intermediate point along the line, towards, or at the point of lowest barometer pressure, will be proportionate to the gradient or slope (as in a liquid stream) in the line drawn from the surface of the mercurial column at the higher to that at the lower station. With the same difference of column, this gradient is steeper as the distance between the columns is less, so that the storm intensity may be represented by the formula $\frac{d}{\delta}$, in which $d =$ the distance in miles between the barometers, and $\delta =$ the differences in the heights of their columns. It follows, therefore, that nothing can be certainly predicted as to the intensity of a coming storm from the *mere* absolute lowness of the barometer, but much from knowing the steepness of the aerial gradient. This is a pregnant and important view, and the author draws from it some practical deductions worthy the attention of the meteorological department of the Board of Trade, &c.

Opinions of the Press on the Fairlie Engine, a Series of Articles, &c.

Here, in one handy octavo pamphlet, Mr. Fairlie has had collected a selection from the more important articles which have appeared in this Journal, in *the Engineer*, the *Times*, and some others, upon the peculiar principles and construction of his double bogie engines. The importance of these remains unaltered, though the engines have as yet received less British attention and patronage than they merit. We commend the work to all our railway and locomotive engineers, as one in which they will find the pith of the subject, concentrated in an accessible form, which it was not while scattered through the pages of many journals and papers. Mr. Fairlie has also reissued his observations on railway carriages, railways and their management, a pushing home only on his part of the same principles.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

PURIFICATION OF THE CLYDE.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—In a short paper I have submitted to the Lord Provost and Town Council of Glasgow, proposing a scheme for the utilization of the sewage and purification of the Clyde, I am fully convinced that tidal flushing, in combination with the gravitation of the sewage under pressure, is the best plan that can be adopted. Mr. Robertson, C.E., has proposed a plan of tidal flushing, somewbat different than what I have advocated elsewhere for the metropolis. He gravitates the sewage into a reservoir, and after being chemically treated, proposes to run this partially purified water into the river, and flushes it away with water impounded with the flow of the tide; a mid wall dividing the river into an impounding reservoir, and a free navigation channel. I think the scheme fully carried out is a good one. So I would propose to form the mid wall of wrought iron and concrete, or brickwork laid in cement —a modification of the channel tunnel you illustrated in your last issue. The plan simply consists in forming the wall hollow, an inner shell of wrought iron, lined with brickwork or plastered over with cement, so as to form a smooth surface covered over with a casing of wrought iron; the space between the casings being filled up with concrete. It would be of an elliptical form and sufficiently high above the water at full tide, so that a pathway would be laid down its entire length. This I propose to sink on the line laid down by Mr. Robertson. Into this great culvert surrounded with water, and lying on the bed of the river, the sewage would simply flow through it, that from the high level intercepting sewers would be conveyed into it by, say, cast-iron piping, and the low level drainage if necessary pumped up a stand pipe. Thus, instead of precipitating the sewage into a reservoir, with suitable branch pipes and sluices the valley of the Clyde could be irrigated, getting rid of the solids, and the purified water would flow into the impounding reservoir, and be flushed away at each tide. At the outfall should be constructed an intercepting basin, so that any surplus would be precipitated before the fluid finds its way into the river; but I consider if the land on the banks of the Clyde is properly irrigated, little or no solid residue will be deposited in the basin.

The advantage consists, in rapidly forming this important undertaking; every shipbuilding yard could be brought to bear on it, and get it quickly finished. And I consider it is a somewhat plainer scheme, than boring and tunnelling through the hills to the Ayrshire coast. I trust your numerous readers in Glasgow will do all they can to forward it, resting assured that the scheme, fully carried out, will effectually purify the Clyde.

I remain, Sir,
Yours truly,
JOHN G. WINTON.

13 Gladstone Street, *October* 19, 1868.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

Premiums, Session 1867–68.

The Council have awarded the following Premiums:—

1. A Telford Medal, and a Telford Premium, in Books, to George Higgin, M. Inst. C.E., for his paper "Irrigation in Spain, chiefly in reference to the Construction of the Henares and the Esla Canals in that country."

2. A Telford Medal, and a Telford Premium, in Books, to Christer Peter Sandberg, Assoc. Inst. C.E., for his Paper "On the Manufacture and Wear of Rails."

3. A Telford Medal, and a Telford Premium, in Books, to Lieut.-Colonel Peter Pierce Lyons O'Connell, R.E., Assoc. Inst. C.E., for his Paper "On the Relation of the Fresh Water Floods of Rivers to the Areas and Physical Features of their Basins."

4. A Telford Medal, and a Telford Premium, in Books, to William Wilson, M. Inst. C.E., for his "Description of the Victoria Bridge, on the line of the Victoria Station and Pimlico Railway."

5. A Telford Medal, and a Telford Premium, in Books, to Charles Douglas Fox, M. Inst. C.E., for his Paper "On New Railways at Battersea; with the Widening of the Victoria Bridge and Approaches to the Victoria Station."

6. A Telford Medal, and a Telford Premium, in Books, to John Wolfe Barry, M. Inst. C.E., for his Paper "On the City Terminus Extension of the Charing Cross Railway.

*7. A Watt Medal to Edwin Clark, M. Inst. C.E., for his Paper "On Engineering Philosophy: the Durability of Materials."

8. A Telford Medal to William Jarvis McAlpine, M. Inst. C.E., for his Paper "On the Supporting Power of Piles; and on the Pneumatic Process for sinking Iron Columns, as practised in America."

9. A Telford Premium, in Books, to Thomas Login, M. Inst. C E., for his Paper "On the Benefits of Irrigation in India; and on the proper construction of Irrigating Canals."

10. A Telford Premium, in Books, to Allan Wilson, M. Inst. C.E., for his Paper "On Irrigation in India."

11. A Telford Premium, in Books, to Wilfrid Airy, Assoc. Inst. C.E., for his Paper "On the Experimental Determination of the Strains on the Suspension Ties of a Bowstring Girder."

12. The Manby Premium, in Books, to Andrew Cassels Howden, Assoc Inst. C.E., for his Paper "On Floods in the Nerbudda Valley; with remarks on Monsoon Floods in India generally."

Subjects for Premiums, Session 1868–69.

The Council of the Institution of Civil Engineers invite communications on the Subjects comprised in the following list, as well as upon others; such as, 1. Authentic Details of the Progress of any Work in Civil Engineering, as far as absolutely executed (Smeaton's Account of the Eddystone Lighthouse may be taken as an example); 2. Descriptions of Engines and Machines of various kinds; or 3. Practical Essays on Subjects connected with Engineering, as, for instance, Metallurgy. For approved Original Communications, the Council will be prepared to award the Premiums arising out of special funds devoted for the purpose.

1. On the present State of Knowledge as to the Strength of Materials.
2. On Steam Cranes, and on the Application of Steam Power in the execution of Public Works.
3. On the Theory and details of Construction of Metal and Timber Arches.
4. On Land-slips, with the best means of preventing or arresting them, with examples.
5. On the Principles to be observed in Laying-out lines of Railway through mountainous countries, with examples of their application in the Alps, the Pyrenees, the Indian Ghâts, the Rocky Mountains of America, and similar cases.
6. On Railway Ferries, or the Transmission of Railway Trains entire across Rivers, Estuaries, &c.
7. On the Systems of Fixed Signals at present in use on Railways.

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* Has previously received a Telford Medal.

8. Description of a Modern English Locomotive Engine, designed with a view to cheapness of construction, durability, and facility of repair.

9. On the leading points of difference between the Engines and Carriages in use on Railways in the United States and in Great Britain, and the reasons for any peculiarities in the American practice, with details of the cost of maintenance.

10. On the most suitable Materials for, and the best mode of formation of, the Surfaces of the Streets of large Towns.

11. On the Construction of Catch-water Reservoirs in Mountain Districts, for the Supply of Towns, for Irrigation, or for Manufacturing purposes.

12. Accounts of existing Water-works; including the source of supply, a description of the different modes of collecting and filtering, the distribution throughout the streets of Towns, and the general practical results.

13. On Pumping Machinery for raising water, both for high and low lifts.

14. On the Drainage of Towns,and the ultimate disposal of town refuse.

15. On the Employment of Steam Power in Agriculture.

16. On the Ventilation and Warming of Public Buildings.

17. On the Design and Construction of Gasworks, with a view to the Manufacture of Gas of high illuminating power; and on the most economical system of distribution of Gas, and the best modes of illumination in Streets and Buildings.

18. Critical Observations on Estuary Tides.

19. On the Construction of Tidal, or other Dams, in a constant, or variable depth of water; and on the use of wrought iron in their construction.

20. On the Arrangement and Construction of Floating Landing-Stages, for passengers and other traffic, with existing examples.

21. On the different systems of Swing, Lifting, and other opening Bridges with existing examples.

22. On the Measure of Resistance to Bodies passing through Water at high Velocities.

23. On the results of the best modern practice in Ocean Steam Navigation, having regard particularly to economy of working expenses, by superheating, surface condensing, great expansion, high pressure, &c.; and on the "life" and cost of maintenance of Merchant Steam Ships.

24. On Ships of War, with regard to their Armour, Ordnance, mode of Propulsion, and Machinery.

25. On the measures to be adopted for protecting Iron Ships from Corrosion.

26. On Coal Mining in Deep Workings, including machinery for dispensing with gunpowder in "getting" Coal.

27. On the present systems of Smelting Iron Ores; of the conversion of cast-iron into the malleable state, and of the manufacture of iron generally, comprising the distribution and arrangement of Ironworks.

28. On Machinery for Rolling heavy Rails, Shafts, and bars of large sectional area, and for Forging heavy masses of metal.

29. On Steel, and its present position as regards production and application.

30. On the safe working strength of Iron and Steel, including the results of experiments on the Elastic Limit of long bars of Iron, and on the rate of decay by rusting, &c., and under prolonged strains.

31. On Machinery for Washing Lead Ores.

32. On the present state of Submarine Telegraphy, and on the Transmission of Electrical Signals through Submarine Cables.

The Council will be glad to receive, for the purpose of forming an "Appendix" to the Minutes of Proceedings, the details and results of any Experiments or Observations on subjects connected with Engineering Science, or Practice.

The Council will not consider themselves bound to award any Premium, should the Communication not be of adequate merit, but they will award more than one Premium, should there be several communications on the same subject deserving this mark of distinction. It is to be understood that, in awarding the Premiums, no distinction will be made, whether the communication has been received from a Member, or an Associate of the Institution, or from any other person, whether a native or a foreigner.

The Communications must be forwarded, on or before the 1st of February, 1869, to the house of the Institution, No. 25 Great George Street, Westminster, S.W., where copies of this paper, and any further information, may be obtained.

JAMES FORREST, *Secretary.*

25 Great George Street, Westminster, S.W.,
October, 1868.

Extracts from the Minutes of Council, February 23, 1835.

The principal subjects for which Premiums will be given are:—

"1st. Descriptions, accompanied by Plans and explanatory Drawings, of any work in Civil Engineering, as far as absolutely executed; and which shall contain authentic details of the progress of the Work. (Smeaton's Account of the Eddystone Lighthouse may be taken as an example.)

"2ndly. Models or Drawings, with descriptions of useful Engines and Machines; Plans of Harbours, Bridges, Roads, Rivers, Canals, Mines, &c.; Surveys and Sections of Districts of Country.

"3rdly. Practical Essays on subjects connected with Civil Engineering, such as Geology, Mineralogy, Chemistry, Physics, Mechanic Arts, Statistics, Agriculture, &c.; together with Models, Drawings, or Descriptions of any new and useful Apparatus, or Instruments applicable to the purposes of Engineering or Surveying."

Excerpt Bye Laws, Section XV., Clause 3.

"Every Paper, Map, Plan, Drawing, or Model, presented to the Institution, shall be considered the property thereof, unless there shall have been some previous arrangement to the contrary, and the Council may publish the same in any way and at any time they may think proper. But should the Council refuse or delay the publication of such Paper beyond a reasonable time, the Author thereof shall have a right to copy the same, and to publish it as he may think fit, having previously given notice, in writing, to the Secretary of his intention. No person shall publish or give his consent for the publication of any communication presented and belonging to the Institution, without the previous consent of the Council."

Instructions for Preparing Communications.

The Communications should be written in the impersonal pronoun, and be legibly transcribed on foolscap paper, about thirteen inches by eight inches, the lines being three-quarters of an inch apart, on the one side only, leaving a margin of one inch and a half in width on the left side, in order that the sheets may be bound.

The Drawings should be on mounted paper, and with as many details as may be necessary to illustrate the subject. Enlarged Diagrams, to such a scale that they may be clearly visible when suspended on the walls of the Theatre of the Institution at the time of reading the communication, should be sent for the illustration of any particular portions.

Papers which have been read at the Meetings of other Scientific Societies, or have been published in any form, cannot be read at a Meeting of the Institution, nor be admitted to competition for the Premiums.

Notice.

It has frequently occurred that, in Papers which have been considered deserving of being read and published, and have even had Premiums awarded to them, the Authors may have advanced somewhat doubtful theories, or may have arrived at conclusions at variance with received opinions. The Council would, therefore, emphatically repeat, that the Institution must not, as a body, be considered responsible for the facts and opinions advanced in the Papers, or in the consequent Discussions; and it must be understood that such Papers may have Medals and Premiums awarded to them on account of the Science, Talent, or Industry displayed in the consideration of the subject, and for the good which may be expected to result from the discussion and the inquiry; but that such notice, or award must not be considered as any expression of opinion, on the part of the Institution, of the correctness of any of the views entertained by the Authors of the Papers.

MANCHESTER LITERARY AND SCIENTIFIC SOCIETY.

THE SUN.

November 3, 1868.—At a recent meeting of this society, Professor H. E Roscoe, F.R.S., drew attention to the important discovery, made independently by M. Janssen at Guntour in India, and by Mr. Norman Lockyer in London, of the visibility of the spectral lines of the red solar prominences under ordinary circumstances. Hitherto these protuberances or red flames have only been seen during total eclipses of the sun; but by the application of the spectroscope in conjunction with the telescope, the peculiar bright lines which these prominences exhibit, indicative of the presence of glowing gas, can now be observed whenever the sun is visible. Although the priority of this interesting discovery is due to M. Janssen, who first observed the protuberances the day after the eclipse, the method having occurred to him whilst observing during the eclipse, yet Mr. Lockyer had suggested this particular method of examination no less than two years ago, and had succeeded in his endeavour before he became aware of M. Janssen's prior observations. From the accounts as far as they are yet published, we learn that the bright lines appear to be identical with those of hydrogen.

Mr. Baxendell stated that this discovery would give a great impetus to the progress of our knowledge of solar phenomena, and that the importance of observations on this plan could not be over-estimated.

Professor H. E. Roscoe, F.R.S., exhibited and explained Carré's apparatus for freezing water by its own evaporation, and by means of which a pint of water was frozen in a few minutes.

OZONE.

"Remarks on Mr. Baxendell's Laws of Atmospheric Ozone," by Professor W. Stanley Jevons, M.A.

In reading the remarks of Mr. Baxendell on atmospheric ozone, it occurs to me that a very simple explanation can be given of the connection he detects between the height of the clouds and the amount of ozone at the surface, two facts which seem at first sight entirely unrelated. The quantity of ozone which reaches the surface will depend on three circumstances:—

1. The thickness of the current of air touching the surface.
2. The proportion of ozone existing therein.
3. The degree in which this current is rendered uniform by constant mixture.

The balloon observations of Mr. Glaisher proved what was previously inferred by meteorologists, that the atmosphere usually consists of several strata of air which are separated by distinct boundaries, and do not freely mix. Hence it is only the ozone in the lowest stratum which is usually available at the surface, and its quantity will be proportioned, *ceteris paribus*, to the thickness of that stratum. It is the height of the first layer of clouds which usually defines the upper limit of this stratum. For during my own observations both in Australia and England I have often noticed that smoke from a great town or from extensive bush fires rises only to a definite height, and seems to form the basis, as it were, of the cumulous clouds, which are the upward terminations of ascending currents. Now, as in May the height of this stratum is, according to Mr. Crosthwaite's observations, greater than in any other month, there will be a larger mass of air which can successively come in contact with the surface and furnish ozone. But we shall only have the full benefit of this ozone when an active process of mixture is going on. At night the air in contact with the earth is cooler than that above, and therefore tends to lie in a stagnant layer which can often be detected by the mist or smoke which it contains. This layer will be rapidly exhausted of ozone, and will be filled with the organic exhalations from the earth. Hence arises the comparatively unhealthy character, and in some climates the poisonous nature, of night air, and it may constantly be observed that a moderate wind may be blowing above our heads, as shown by the motions of the clouds or the wind felt on a mountain top, without breaking up the stagnant layer on the surface. This is one reason why the air is calmer at night than in the day. But during high winds the gusts penetrate to the surface and prevent any stagnation, so that, as I apprehend, during stormy weather the deficiency of ozone in the evening would not be observed.

In the day time, on the contrary, the sun's heat occasions a perpetual circulation or convection in the lowest mass of air up to the level of the cumuli. Every portion of the air is thus successively brought to the surface, and organic substances are carried off and oxidated.

During my own observations on ozone I felt strongly the imperfections of the method of measurement alluded to by Mr. Baxendell, and I thoroughly agree with him that the mysterious variations of ozone will not be understood until not only the quantity of air brought into contact with the paper be measured or regulated, but the varying source and magnitude of supply be considered."

ROYAL SCOTTISH SOCIETY OF ARTS.

REPORT OF THE COMMITTEE APPOINTED BY THE ROYAL SCOTTISH SOCIETY OF ARTS TO AWARD THE PRIZES FOR COMMUNICATIONS LAID BEFORE THE SOCIETY DURING SESSION 1867-1868.

The committee having met, and carefully considered the communications submitted to the society and reported on during the Session 1867–68, beg to report that they have awarded the following prizes:—

1. To Thomas Stevenson, Esq., C.E, F.R.S.E., for his communication on new arrangements for lighthouse illumination, No. 4170, read 27th January, 1868: and
2. To William Swan, Esq., F.R.S.E., Professor of Natural Philosophy in the University of St. Andrews, for his communications on new forms of lighthouse apparatus, No. 4169, read 9th December, 1867, and No. 4173, read 27th January, 1868.—Jointly the Keith Prize, value Forty Sovereigns.
3. To David Stevenson, Esq., C.E., F.R.S.E, for his communication on aseizmatic arrangements designed for structures in countries subject to earthquakes, read 9th March, 1868 (No. 4182).—The Macdougall Brisbane Prize, value Ten Sovereigns.
4. To Robert W. Thompson, Esq., C.E., F.R.S.E., for the description of his "pot" steam-boiler, read 9th March, 1868 (No. 4181).—The Hepburn Prize, value Ten Sovereigns.
5. To Robert M. Ferguson, Esq., Ph D., F.R S.E., for his communication on a new way of obscuring window glass, read 13th April, 1868 (No 4186)—The Society's Silver Medal.
6. To Mr. Hugh Fraser, Stirling, for his description of his "Geocentric Indicator," designed for elementary instruction in Astronomy, and exhibited to the society 13th April, 1868 (No. 4175).—The Society's Silver Medal.

In addition to the *thanks* that are due to all who have favoured the society with communications during the past Session, the committee recommend that *special thanks* should be given to the following gentlemen:—

1. To John Ross, Esq., Invergordon,—For his description of a platinum and silver retort, read 23rd March, 1868 (No. 4183).
2. To Mr. William Thorburn and Dr. R. Pairman, Biggar, for their joint communication on milk-churning, read 13th April, 1868 (No. 4185).
3. To Thomas Strethill Wright, Esq., M.D., for his communication on the nature of the "chill" occurring on the surfaces of certain varnishes, and on its remedy, read 27th April, 1868 (No. 4180).

Humbly reported in name of the Committee by

EDWARD SANG,
Sec., Convener ex officio.

Society's Hall, 117 George Street,
October 16, 1868.

MONTHLY NOTES.

Wrecks during 1867.—It appears that 2513 ships, with a registered tonnage of 464,000 tons, were wrecked off our coasts with a loss of 1333 lives. This was a larger number of wrecks than any hitherto registered. The average number of wrecks during the last nine years has been 1961 per annum. Of the losses during the past year 414 were cases of collision, the rest attributable to wrecks properly so called, and other casualties. It does not say much for the seaworthiness of many of the vessels that 729 were wrecked when the wind did not exceed a strong breeze. By far the greatest number of wrecks occurred on the east coast.

Boots and Shoes.—Mr. G. F. Chase, of Boston, patents an invention for a mode of imparting increased support and strength to the back or heel portions of the uppers of boots or shoes, consisting in the employment of a steel or other metal tongue piece or plate, which is so bent as to enable one part to be inserted between the heel and the inner sole, whilst the other part extends upwards between the lining and the upper leather at the back or heel of the boot and shoe. This metallic support is secured firmly in its place between the heel and the inner sole by nails, pegs, or other suitable fastenings, passed through holes made for that purpose in the metallic support; the part which extends under the upper is also maintained securely and firmly in its place by inserting a row or rows of stitches on each side thereof, such stitches uniting the upper with the inner leather or lining, and thus effectually preventing any displacement of the metallic support. These supports may, in some cases, be used in substitution for the usual counters, or they may be combined therewith as preferred. Fig. 1 of the engravings represents a vertical section of the hind portion of a boot strengthened and supported according to this invention. Fig. 2 is a perspective view of the strengthening plate detached. *a* is the outer or upper leather of the boot, and *b* is the inner leather or lining of the same; *c* is the outer sole, and *d* the inner sole. Between the upper, *a*, and lining, *b*, and between the outer sole, *c*, and inner sole, *d*, there is introduced the bent steel or other strong metal plate, A, fig. 2. The horizontal part, *e*, of such plate is bent at or near a right angle to the upright part, *f*, and both these parts are suitably curved transversely, so as to present a hollow or concave curved surface to the interior of the back of the boot, and to the inner surface of the heel. This strengthening plate is inserted in its place during the operation of making the boot; the part, e, being accurately imbedded upon the inner surface of the outer sole and that portion of the heel of the upper leather which is turned in during the process of lasting, as shown clearly in fig. 1, and is secured by nails, pegs, or other fastenings, passed through holes made for that purpose in the part, *e* (see fig. 2), and driven into the body of the heel, *g*. The upright part, *f*, is inserted between the outer leather, *a*; and the lining, *b*, is retained in its proper position by introducing one or more rows of stitches, *h*, uniting the outer and inner leather in close proximity to the edge of the upright portion, *f*, of the strengthening plate. These metallic supports may be made from flat plates punched out to the proper contour, and then shaped or bent into the desired form by the aid of dies and matrices, or other suitable devices.

Fig. 1.

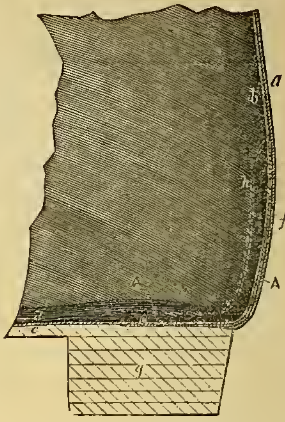
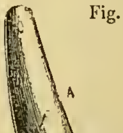


Fig. 2.



The New Smithfield Market, London.—Below, and communicating with the building, is a spacious and central depôt in connection with several converging lines of railway, where meat and poultry can be brought from any part of the kingdom, and raised by hydraulic agency directly into the market and in the trucks in which they are conveyed. The excavation under the market site alone, exclusive of the vaulting around, required the removal of 3,500,000 cubic feet of earth, weighing about 172,000 tons. The roof of the railway depôt forming the floor of the market had then to be formed. This consisted of 21 main girders, of great size, extending across the width of the market—namely, 240 feet, carried on piers or columns of wrought iron. On the main girders, cross girders 2 feet 6 inches deep, and 7 feet 6 inches apart, were laid running the whole length of the building, 625 feet, and between these cross girders brick arches were turned, on which concrete was laid to receive the paving of the market above. Some idea may be formed of the extent of these works when it is stated that nearly five miles of girders are employed, carried on 180 columns, and that 3000 tons of wrought iron are used to support the floor of the market. The area of this building is a parallelogram, 631 feet by 246 feet, and extends over about 3½ acres. The style of the architecture is Italian. The prevailing feature is a series of arcaded recesses between Doric pilasters, fluted in the upper parts and elevated on pedestals. The entablature is ornamental over the pilasters, and has vase-like terminations recurring at regular distances throughout the length of the building. The general height of the external wall is 32 feet, and the lower parts of the recesses between the Portland stone pilasters are built in red brickwork. The semicircular heads of the arches above are filled with iron scroll-work, so ample in design as to occupy the space, and yet leave room for the admission of air and light. The keystones of the arches are richly carved, those especially over the side entrances. The chief points of architectural effect are the fronts of the public roadway which passes through the market. The roadway is 50 feet wide, and its sides are shut off from the market by an elaborate screen of open ironwork, 14 feet high, while at the intersection with the central avenue which runs east and west the market is closed by gates of ornamental ironwork. Towards the north end of the roadway access is obtained by a double staircase to the railway depôt below; near this the post and telegraph offices and market officers' rooms are placed, and four lofty towers mark the angles. The gates at the east and west ends are of elaborate design and great size, weighing 15 tons each, and each of them is 20 feet high by 19 feet wide. The twelve side entrances, six on the north and six on the south fronts, are also of considerable size and similar in design. One of the leading features in the arrangement of the interior is that for securing light without sunshine, and free ventilation without exposure to rain. During the excessive heat of last summer the effect was tested by thermometers placed in various parts of the building, and the result found to be highly satisfactory, the interior never being less than ten degrees cooler than the shade outside. The upper parts of the roof all over the building are of wood and communicate with other portions of the fabric, which are also of wood. In the event of fire it would probably spread with terrific rapidity through the building. The wooden portions of the roof have also the effect of throwing the avenues somewhat into shade. The shops are arranged on each side of the side avenues which cross the market from north to south, and intersect the central avenue. The latter is 27 feet wide, and the six side avenues 18 feet wide each. There are 162 shops, 36 feet by 15 feet. At the western end space is reserved for dealers in poultry and game, but no fish or vegetables will be sold in this market. The backs of the shops are closed in, but at the sides are screened by light ironwork to insure ventilation. The floor of the market is paved with wood blocks. Twelve hydrants, always at high pressure, will supply ample means of washing out the market avenues and stalls, and could be used in case of fire.—*Times.*

Improved Mowing and Reaping Machine.—The annexed woodcuts illustrate an elevation and modified detail of a mowing and reaping machine, recently patented by Messrs. Hodgson and Dodd, of Swetton, Yorkshire. In this machine the mowing power, acting on the cutting knife, is derived from either one or two levers, provided with small rollers at the ends. These rollers act upon vertical or other corrugations or indentations on a wheel placed loosely on the driving axle, such wheel being thrown in and out of gear by an ordinary hand lever and sliding clutch box. The corrugations or indentations on the loose wheel are placed on the extreme edge of the wheel on the one side for corn, and on the other side for grass. Fig. 1 is a side elevation of the improved machine, as arranged for cutting corn. *a a* is the main axle on which hangs the cast-iron framing, *b b*, which supports the cutting apparatus; c c is the driving wheel, which is keyed fast upon the axle, *a a*, a similar wheel being mounted loosely at the other side of the axle, so as to enable the machine to be turned round a corner without difficulty; *e e* is the indented or corrugated wheel, which is also mounted loosely on the driving axle, but is connected therewith and driven thereby (when the cutters are required to act) by means of a sliding clutch, which is thrown in or out of gear by the hand lever, *g g*. A bracket, *h h*, rises from the cast-iron frame, *b b*, and supports the fulcrum of a lever, *i i*, one end of which carries a pin, or anti-friction roller, which projects into the indentation of the wheel, *e e*. The other end of this lever is connected by a rod or link, *k k*, to a -piece, or bell crank, *l l*, the lower arm of which is attached to and works the cutting knife. If the machine is intended to cut both corn and grass, there will be a set of indentations on each side, one set suited for cutting corn and one for grass, and the lever, *i i*, will be so arranged that it can be actuated by either set of indentations, as may be required. For raising and lowering the apparatus, a lever, *n n*, is mounted on a fulcrum attached to the pole, *o* o, and its end connected by a chain, *p p*, to the cast-iron frame; *q q* is a catch lever for holding the lever, *n n*, in position till released. Fig. 2 represents an edge view of a modification of a part of the improved machine arranged for cutting grass only. In this arrangement the wheel, *e e*, is corrugated on both sides. The lever, *i i*, is provided with two pins or anti-friction rollers at its upper end (one working on each side of the wheel, *e e*), and its lower end is connected directly with the cutting knife, without the intervention of the ┬-piece or bell crank. The fulcrum of the lever, *i i*, is in this case carried by a bracket bolted to the cast-iron frame, *b b*. The lever and chain for raising and lowering the cast-iron frame, *b b*, may also in this case be dispensed with.

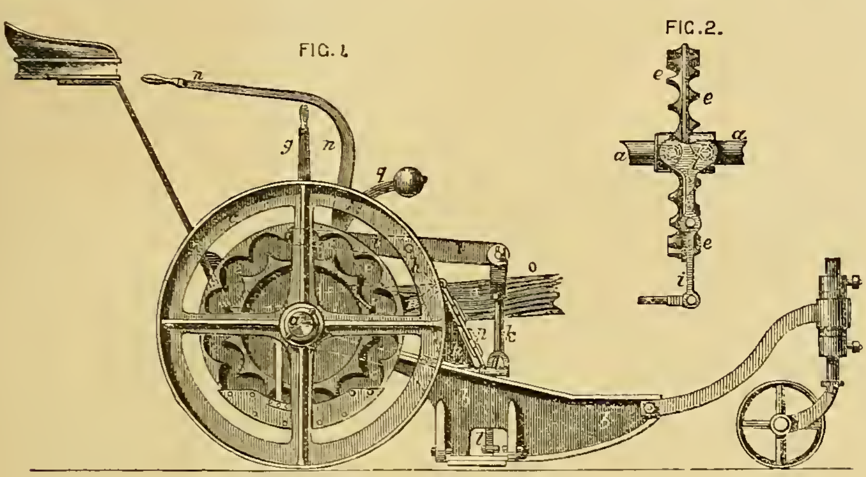


FIG. 1

FIG. 2

Havre Exhibition.—This exhibition has been closed by a ceremony and banquet, at which the Minister of Commerce was the guest of honour, being supported by all the notabilities of the town and department. In an excellent practical speech, the minister referred to the importance of the commercial relations between England and France, which since 1848 had grown in value from eight to seventy-two millions sterling per annum. He also made special reference to the large proportion of English amongst the foreign exhibitors, the numbers in the official report being as follows:—

Great Britain,	494
North and South America,	262
Germany,	193
Belgium,	178
Holland,	123
Denmark,	52
Switzerland,	36
Turkey,	32
Italy,	23
Spain,	21
Portugal,	11
Persia,	2
Siam (the King),	1
	1,428

The number of French exhibitors amounted to 4427, exclusive of the fine art department, agricultural, horticultural, and other shows, in which foreigners took no part.

The lists of awards are not yet completely made up, but the following are the principal recompenses accorded to British exhibitors:—

Diplomas of Honour.

Messrs. Napier and Sons, Glasgow, the only recipients in the shipbuilding class of this highest award, with the exception of the Great Steam Company of the Messageries Impériales.
Messrs. Parkinson and Frodsham, London.—Chronometers.
Frank Buckland, Esq.—Pisciculture.
The Barrow Hæmatite Steel Company.
James Russell, Wednesbury.—Iron tubes.
Thomas Daniel and Co., London.—Colonial products.
Wayne and Co., Cardiff.—Coal.

Gold Medals.

Mr. Claude Martin, Newcastle.—Anchors.
Kulberg, London.—Chronometers.
The Board of Trade, London.—Rocket life-saving apparatus.
Mr. George Borthwick, London.—Baking Powder.
Mr. Schmidt, Liverpool.—Road locomotive.
Price's Patent Candle Co.
Crace Calvert and Co., Manchester.—Phenic acid.
Sir William Rose and Co., London.—Railway grease.
J. C. and J. Field, London.—Candles.
John Bowes and Co.—Coke.
John Brogden and Sons.—Coal.
Johnson and Co., London.—Cements.
Francis and Co., London.—Cements.
Hinks, Wells, and Co.—Steel pens.

The other medals and awards cannot be given with accuracy at present, and the list is long. In Class I., shipbuilding, &c., there are a dozen awards to English exhibitors, and in Classes III. and IV. as many, if not more.

The Mont Cenis Tunnel.—During the first fortnight of the past month (October) the progress made at the Mont Cenis Tunnel was 53·05 metres; of which 23 90 were driven on the Italian side at Bardonnèche, whilst the advancement made on the French side at Modane was 29·15. The position of these works up to the 15th October was as follows:—

	Metres.
Length driven at Bardonnèche,	5,235·00
Length driven at Modane,	3,660·65
Total length of tunnel driven,	8,895·65
Length remaining to be driven,	3,324·35
Total length of tunnel	12,220·00

Russian Telegraphs.—The establishment of electric telegraphs in Russia dates from 1853. The first laid down were from Petersburg to Moscow, Cronstadt, Varsovia, and Kœnigsberg. An agreement was made with Prussia for the establishment of the latter line, and with that commenced the international telegraphic correspondence with the other European states. The telegraphic network spread in a short time over all Russia. In the space of thirteen years the two capitals were placed in communication with the most important and distant towns, and with the bordering states. Laying down the electric telegraph in Russia presents infinitely greater difficulties there than in the rest of Europe, not so much on account of the immense distances as of the climate, smallness of population, variety of governments, high salaries of workmen, and the expense of the transport of materials. In 1865 there were already 61,450 versts of telegraphs, with 323 stations, and 1,644,375 messages were dispatched. To complete the work, there remains the line which, passing through Siberia, will join America, and which, it is supposed, can be opened in 1870. In the years 1864 and 1865 a telegraphic communication was established with Persia by the Caucasus; the line is continued beyond, towards India. A special agency has been established at Pekin for the sending of Russian-Chinese messages. This agency has the difficulty of overcoming the distrust of the Chinese government in regard to telegraph communication. Up to the present time this government has telegraphed news to their distant provinces by means of beacon fires. It takes six days for the transmission of news by this means through Tartary. The Russian messages are still even sent to the frontier of Pekin by post.

International Coinage.—The conclusions of the Royal Commission appointed to consider the possibility of establishing an international coinage are as follows:—"The adoption of the proposal of the Paris Conference, of merely reducing the value of the pound to that of 25f., would facilitate the comparison of sums stated in large coins; but the difficulty would remain of comparing sums expressed in pence in England, in centimes in France, or in cents in the United States, and it is seldom that statements of prices or statistical returns do not contain sums expressed in these small denominations. The reduction of the value of the pound would disturb all existing obligations, and would cause many and serious difficulties; while if at any future time a more complete assimilation of coins should be determined upon, a further change would be required, in many respects more difficult of application. The measure is, after all, only a partial measure, and although advocated by some witnesses as good in itself, and as a step to further assimilation, the object sought for by the witnesses connected with the trade and with the scientific bodies of this country would not be fully attained by anything less than a complete assimilation of the currencies of different countries. Several witnesses who took this view deprecated any change unless a complete assimilation of currency of moneys of account as well as of coins was made; and it is a serious objection that by this step all the admitted evils of the change in the value of the pound would be incurred, while the advantages by which it is anticipated that those evils would be compensated would not be attained. Upon full consideration of all these circumstances, we do not recommend that this country should merely adopt a gold coin of the value of 25f. to be substituted for the sovereign. We have felt it to be our duty to state the grounds on which, with a view to the general interest of the commerce of the world, the English sovereign and pound might form a convenient basis for international currency. The consideration of such a question, however, leads to one of a much more important character—namely, that of a complete assimilation of the currencies of at least the principal commercial countries. We entertain no doubt that an uniform system of coins, bringing into harmony the various standards of value and moneys of account, alike in their higher denominations and their lower subdivisions, as well as an uniform system of weights and measures, would be productive of great general advantage. The latter proposal, however, is not referred to us; and we will only say, therefore, that we do not consider it necessary that any measures for the assimilation of the currencies of the principal countries of the world should be postponed until steps are also taken for the assimilation of weights and measures. We are not insensible of the many and serious difficulties which must attend any attempt to effect a general assimilation of the currencies of different countries. Under any circumstances, great inconveniences must be encountered by many, if not by all, the countries joining in any monetary convention for such purpose; but the arrangement is one in which all commercial countries are interested, and none more deeply than our own. It would obviously conduce to a probable agreement, that the burden of inconvenience should not press very unequally on any of them. What should be the common basis of their currencies, what international coin should be adopted, what proportion of alloy it should contain, what should be its subdivisions or multiples, are all matters on which an agreement must be arrived at before any assimilation can be attained. On all these points widely different opinions may be held in different countries, and on the determination of them depends the degree of inconvenience to be sustained by each country. To what extent of inconvenience any country may be willing to submit for the sake of establishing a common international system of currency can only be ascertained by communication with the government of each country. It is obvious that before any agreement can be concluded very difficult and complicated questions will have to be settled, concessions will have to be made on one part and on the other; and it will also be an important matter for consideration how far an agreement may be facilitated by making the changes which are necessary bear on any country as lightly as is consistent with the attainment of the common object. The assembling of some general international conference on the subject seems to have been looked forward to by many members of the conference at Paris; and we are disposed to think that all the various questions might be best considered, the various interests of different countries discussed, and their conflicting views reconciled by authorized representatives of the different countries meeting in such a conference."

MESSRS. DUBALLE & LAMBELIN'S LUBRICATORS FOR STEAM CYLINDERS.—The annexed engravings represent a lubricator for steam cylinders, the invention of Messrs. Duballe and Lambelin, of Paris, in which a single vertical cock and a movable receptacle are employed. It is composed of a receptacle, *b*, and of a single plug, which may be of either a straight or swan-necked form, and terminate in one or more tubes, according as it is required to lubricate on one or several adjacent points. The receptacle has two holes, *a* and *c*, formed in it, and the cock contains two cylindrical chambers situated one above the other, as shown in fig 2. When oil is poured into the cup, *f*, it descends into the upper chamber of the plug and passes into the receptacle through the hole, *a*, which is in communication with a hole in the plug. When the receptacle is full it is turned a quarter-turn, which brings the hole, *c*, opposite the hole, *d*, in the plug, and the oil passes into the chamber, *g*, which communicates with the cylinder. A screw is provided at the lower part of the plug, to act as a stop and insure the holes being exactly in juxtaposition. At the top part of the receptacle an air hole, *e*, is formed, above which is a small tube, *f*, for the escape of the air contained in the receptacle when the oil is introduced; the hole, e, communicates with the receptacle by means of a groove formed in the plug. This lubricator remedies some of the defects to which the two-cock lubricators ordinarily employed are liable. It sometimes occurs that in consequence of the play they acquire by being worked when they are believed to be secure, they frequently open spontaneously, so as to cause the escape of the steam. This cannot take place with this apparatus, as the steam is never in communication with the cup, *f*, one of the orifices leading from the interior to the exterior being always closed when the other is open.

Fig. 1.

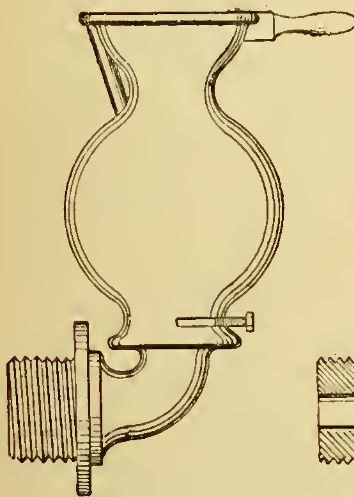
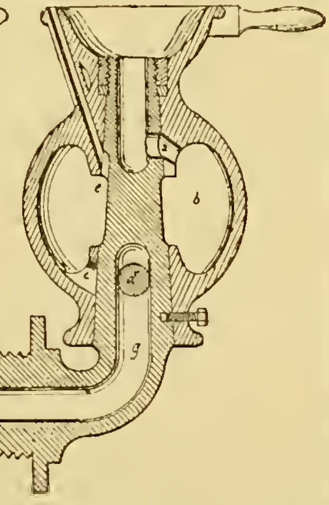


Fig. 2.



THE ELECTRIC LIGHT.—The *Athenæum* says, "M. Haussman's irrepressible energy, directed to the reconstruction of Paris, has recently assumed a new phase. Daylight being insufficient to enable certain works to be completed in the desired time, the aid of M. Serrin's beautiful and ingenious apparatus for the automatic regulation of the carbon electrodes of electric lamps has been called into requisition. The intense nature of this light is such that it has been used with great success in obtaining photographs of the catacombs under Paris, and also of the sewers, and it is now employed to enable masons and other workmen to labour through the night hours."

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

28th September, 1868.

2967 J. Shepherd, Whitefield—Preventing smoke in furnaces
2968 C. D. Abel, Chancery Lane—Converting cast iron into wrought iron.—A com.
2969 W. M'Adam, Glasgow—Facilitating omnibus traffic
2970 J. Gregory, Bristol—Preparing animal charcoal
2971 G. A. C. Bremme, Liverpool—Untwisting strands
2972 R. Duncan, Billericay—Earth closets
2973 J. Robinson, Heston—Ploughs

29th September, 1868.

2974 T. Briggs, Manchester—Securing bales
2975 J. Smith, Manchester—Weaving fustians
2976 J. Wadsworth, Manchester—Economizing fuel
2977 W. E. Gedge, Strand—Safety belt.—A com.
2978 A. M. Clark, Chancery Lane—Raising and lowering apparatus.—A com.
2979 J. H. Irwin, Chicago—Illuminating apparatus
2980 E. T. Hughes, Chancery Lane—Gas burners.—A com.
2981 A. H. Brandon, Paris—Watch-case spring.—A com.
2982 J. Foster, Halifax—Preparing paper for cartridge cases
2983 A. V. Newton, Chancery Lane—Boots and shoes.—A com.
2984 W. Hallam and H. J. Madge, Swansea—Converting tin shearings into tin plates
2985 L. Hannart and N. A. Aubertin, Clerkenwell—Moulding wheels
2986 H. J. and J. W. Girdlestone, Westminster—Preventing compass deviations

30th September, 1868.

2987 E. Horton, Birmingham—Chandeliers
2988 G. Daws, Penge—Opening and closing cart gates
2989 W. Gadd, Nottingham, and J. Moore, Manchester—Looms for weaving
2990 H. Jewitt, Kentish Town—New game.—A com.
2991 V. Juge, New Bridge Street—Propelling vessels
2992 J. Mabson, Norwood—Candlesticks
2993 J. Lambert, Norwich—Raising water
2994 A. Lafargue, Newcastle-on-Tyne—Steam gauges
2995 W. Richardson, Oldham—Cleaning wool
2996 W. E. Newton, Chancery Lane—Treating metals.—A com.
2997 W. E. Newton, Chancery Lane—Scissors sharpener.—A com.
2998 J. H. Johnson, Lincoln's Inn Fields—White lead.—A com.
2999 G. A. F. E. Dalrymple, Logie Elphinstone—Clipping horses
3000 O. W. Powers, Regent Street—Sewing machines.—A com.
3001 J. Woollatt and W. B. Dodds, Gravesend—Propelling vessels
3002 G. Unwin, Sheffield—Breech-loading fire-arms
3003 B. W. Stevens, Birmingham—Looms for weaving
3004 A. F. Becks and G. Johnson, Birmingham—Rouge

1st October, 1868.

3005 T. Fisher, Little Ilford—Supporting rollers for blinds
3006 H. Highton, Brighton—Artificial stone
3007 G. T. Bousfield, Brixton—Tufted fabrics.—A com.
3008 J. D. Scally, Burton-on-Trent—Filling casks
3009 J. F. G. Kromschrœder, Camden Town—Generating gas
3010 J. Murray and O. Harling, Keighley—Consuming smoke
3011 D. Crichton, W. Donbavand, and D. Crighton, Manchester—Looms for weaving
3012 C. B. Chardon, King William Street—Locomotive engines
3013 R. Legg, Clerkenwell—Twisted tobacco
3014 J. Olivier, Rue Moreau, St. Antoine—Obtaining motive power
3015 A. Thorpe, Codnor—Cages for mines
3016 W. E. Newton, Chancery Lane—Decorticating grain.—A com.
3017 W. R. Lake, Chancery Lane—Furnaces.—A com.

2nd October, 1868.

3018 F. A. Calvert, Manchester—Cleaning wool
3019 G. Holcroft and W. N. Dack, Manchester—Steam-engines
3020 J. F. and S. Jenkins, Birmingham—Sleeve links
3021 E. O'Connell, Greenwich—Nourishing infants
3022 A. Monsnergue, Paris—Kilns
3023 N. Henwood, St. Germans—Mowing and reaping machines
3024 R. F. Drury, J. E. and W. G. Walker, Sheffield—Crank braces
3025 S. Bates, Nottingham, and W. Redgate, Radford—Twist-lace machines
3026 C. E. Brooman, Fleet Street—Manufacturing candles.—A com.
3027 T. C. Parson, Bristol—Skates

3rd October, 1868.

3028 E. F. Rose, Provin—Breaking flax
3029 Z Shrimpton, Redditch—Packing needles for sale.
3030 J. Baker, Liverpool—Removing vegetable adhesions from iron ships
3031 J. Rogers, Liverpool—Reviving bone black after usage.—Partly a com.
3032 D. West, Euston Square—Presses
3033 B. E. R. Newlands, Charlton—Manure
3034 E. A. Cowper, Westminster—Iron and steel

5th October, 1868.

3035 J. Howden, Glasgow—Preventing the escape of heat from cylinders
3036 R. Heilmann and P. Hart, Manchester—Utilizing waste vapours
3037 J. B. Joyce, Bradford—Valves for steam engines
3038 W. R. Lake, Chancery Lane—Extension chandelier.—A com.
3039 C. F. Galand, Liége, and A. Sommerville, Birmingham—Repeating fire-arms

6th October, 1868.

3040 E. T. Bellhouse and W. J. Dorning, Manchester—Hydraulic presses
3041 E. Simons, Sheffield—Railway breaks
3042 N. Tchepelevsky, Marylebone—Enamel applicable to wood.—A com.
3043 J. R. Wigham, Monkstown—Illuminating lighthouses
3044 G. Graveley, Bow—Steam-pumps
3045 F. S. Gilbert and W. G. White, Lawrence Pountney Lane—Self-adjusting spanners

3046 A. G. Straker, Leadenhall Street—Sample bag
3047 R. Ramsay, Cavendish Square—Shoes
3048 T. Garnett, Smethwick—Hydraulic rams
3049 H. Steffanson, Brompton—Sawing machinery
3050 J. G. Willans, St. Stephen's Crescent—Iron and steel
3051 J. Aspinall, Harrow—Telegraphic cables
3052 J. Jeffreys, Upper Norwood—Preserving meat
3053 C. Eskrett, Kingston-upon-Hull—Extracting oil from seeds

7th October, 1868.

3054 F. P. Warren, Lee—Cooking apparatus
3055 J. H. Johnson, Lincoln's Inn Fields—Textile fabrics.—A com.
3056 D. Marshall, Leith—Packing for condensers
3057 W. Sievwright, Prinlaws, and G. Worrall, Dundee—Producing pressure on rollers
3058 J. H. Johnson, Lincoln's Inn Fields—Spinning cotton.—A com.
3059 R. T. Monteith, Dinard—Fire-bricks
3060 E. T. Hughes, Chancery Lane—Generating electricity by heat.—A com.
3061 W. Rossitter, Accrington—Warping machines
3062 J. Wood, Stockport, and J. Arundall, Hollingworth—Shuttles
3063 W. E. Newton, Chancery Lane—Knitting machinery.—A com.
3064 J. Watson, Newington Causeway—Wall papers
3065 J. Dnpree, Whitechapel Road—Sieves
3066 J. Watson, Newington Causeway—Wall papers
3067 W. Estor, Hampstead, and E. T. Pearce, Regent Street—Disinfecting rooms
3068 W. Richards, Birmingham—Cartridges
3069 R. H. Bentham, Bedford Row—Drawing apparatus

8th October, 1868.

3070 H. Josephi, Manchester—Watches
3071 G. Speight, Clerkenwell—Applying adhesive agents to paper
3072 J. Chaudron, Brussels—Boring mines
3073 J. Barcroft, Newchurch—Felted cloth
3074 J. M'F. Gray, Birkenhead—War turrets
3075 E. J. Hughes, Manchester—Recreative games.—A com.
3076 T. Sagar and J. Richmond, Burnley—Looms for weaving
3077 F. Ayckbourn, Strand—Lead pencils
3078 E. Prevost, Euston Road—Controlling restive horses
3079 J. H. Johnson, Lincoln's Inn Fields—Saw bandles.—A com.
3080 W. Simons, Renfrew—Bricks
3081 J. Steel, Glasgow—Obtaining extracts from roasted malt
3082 W. Bland, Keighley—Looms for weaving
3083 G. Davies, London and Glasgow—Paper boats.—A com.
3084 J. Arnold, Sheffield—Steam-boilers
3085 R. Winder, Dartford—Boring machines for hop poles
3086 J. Dewar, Kirkaldy—Food
3087 J. Dewar, Kirkaldy—Preserving manure
3088 F. Zysel, Birmingham—Expanding frames
3089 T. Heacock, Drury Lane—Door knobs
3090 M. P. Manfield, Northampton—Boots and shoes
3091 W. E. Newton, Chancery Lane—Binnacle for ships.—A com.
3092 A. MacMillan, Mildmay Park—Buttons

9th October, 1868.

3093 J. Varley, Leeds, and S. W. Varley, Dresden—Treating waste silk
3094 H. A. Bonneville, Piccadilly—Pumps.—A com.
3095 J. Peel, J. F. Broadhent, and J. M. Baines, Bradford—Looms for weaving
3096 W. Jarvis, New Brighton—Labels for poison bottles
3097 T. W. Dyer, Barnsbury Road—Antichimney-smoker
3098 H. Deacon, Appleton—Sulphuric acid
3099 L. Hannart and N. A. Auhertin, Cheapside, and W. J. Cunningham, Oxford Street—Door plates
3100 E. Evans, Neath—Propelling boats on canals
3101 H. A. Archerean, Paris—Obtaining beat
3102 W. E. Newton, Chancery Lane—Ascertaining the number of fares obtained by omnibus conductors.—A com.
3103 W. J. Curtis, Holloway—Sewing machines
3104 S. Tragheim, Gray's Inn Road—Washing and cooking
3105 J. C. Morgan, H. Macaulay, and F. W. Waide, Rotherham—Cast-iron cisterns
3106 W. T. Read, Old Broad Street—Treating bottles
3107 B. Walker and J. F. A. Pflaum, Leeds—Reducing bull-dogs
3108 J. Griffiths, Chesterfield—Iron and steel
3109 D. and G. Hallas and S. J. Woodhouse, Leeds—Regulating the supply of gas to burners

10th October, 1868.

3110 G. P. Grant, Wandsworth Road—Bung bushes for casks
3111 F. Barnett, Paris—System of paving
3112 T. Merz, Hebburn, and G. Thomson, Pelaw-Main—Calcining ores
3113 R. Tod, Glasgow—Cleaning wheat.—A com.
3114 S. J. Maccarthy, Fitzroy Square—Securing boots
3115 F. A. Ahel and E. O. Brown, Woolwich—Firing explosive compounds
3116 W. H. S. Auhin and B. Benton, Wolverhampton—Taps
3117 W. R. Lake, Chancery Lane—Electro-plating.—A com.
3118 F. W. Hart, Kingsland Green—Varnishes for protecting lithographs

12th October, 1868.

3119 N. Smith, Glasgow—Treating waste acid liquors
3120 C. D. Abel, Chancery Lane—Propelling vessels.—A com.
3121 J. Moon, J. H. Donaldson, and S. J. Harris, Oxford Street—Fastening bedsteads
3122 W. Moodie, Glasgow—Propelling ships
3123 T. B. Jordan, South Lambeth—Dressing mineral substances
3124 S. Leoni, New North Road—Heating and cooking apparatus
3125 A. Field and A. W. Tuer, Minories—Tablets
3126 W. Brailsford and J. Gadsby, Nottingham—Manufacturing lace

13th October, 1868.

3127 J. Ward, Clapham—Communicating in railway trains
3128 T. F. Cashin, Sheffield—Securing the joints of rails
3129 W. A. Lyttle, London—Electro-telegraphic conductors
3130 H. C. Clifton, Clerkenwell—Ornaments for picture frames
3131 F. A. Le Mat, New Orleans—Revolving fire-arms
3132 G. N. Sanders, Portland Place—Lamps
3133 W. T. Sugg, Westminster—Regulating the supply of gas
3134 R. Dawson, Plymouth—Gun-boats
3135 R. Spice, Gower Street—Tobacco jars
3136 J. Worster, Camberwell—Holding stereotype plates
3137 W. Yates, Westminster—Furnaces
3138 W. R. Lake, Chancery Lane—Dyeing hair.—A com.

14th October, 1868.

3139 R. Rowbotham and C. Ezard, Manchester—Fireplaces
3140 J. Shanks, Barrhead—Waterclosets
3141 L. Clozel, Paris—Tanning animal skins
3142 W. R. Lake, Chancery Lane—Drilling small holes.—A com.
3143 J. H. Carter, Brighton—Lubricating apparatus
3144 W. R. Lake, Chancery Lane—Spinning wool.—A com.
3145 J. G. Jones, Newport—Apparatus for getting coal
3146 J. Robertson, Glasgow—Motive power
3147 E. Leach, Rochdale—Travelling lattices
3148 J. Atkins, Birmingham—Metallic tubes
3149 W. Lorlerg, City Road—Treating cotton seed
3150 H. Hudson, Wolverhampton—Railway rolling stock
3151 W. R. Lake, Chancery Lane—Generating hydrocarbon liquids.—A com.
3152 J. Denley, Cheltenham—Coffee pot

15th October, 1868.

3153 C. G. Gumpel, Leicester Square—Locks and latches
3154 W. E. Gedge, Strand—Agglomerating coal dust.—A com.
3155 H. A. Bonneville, Piccadilly—Elastic moulds.—A com.
3156 E. Fort and J. Lee, Burnley—Steam-boilers
3157 G. C. Attree and T. Dermer, Cheapside—Fastening scarfs
3158 A. Robins, Great St. Helens—Drain pipes.—A com.
3159 E. Peyton, Birmingham—Spring mattresses
3160 T. Gray, Taibach—Safety lamps
3161 J. Ball, Nottingham, and A. Ball, Radford—Manufacturing lace
3162 R. M. Wood, Stoke Newington—Type cases
3163 J. A. Vacherot, Notting Hill—Constructing buildings
3164 W. R. Lake, Chancery Lane—Breech-loading volley-firing guns.—A com.
3165 W. R. Lake, Chancery Lane—Breech-loading fire-arms.—A com.

16th October, 1868.

3166 T. and T. Vicars and J. Smith, Liverpool—Self-feeding furnaces
3167 R. Pearce, Swansea—Separating copper from silver and gold
3168 R. M. Marchant, Fleet Street—Railways
3169 W. C. Church, Derby—Steam-engines
3170 R. Head, Manchester Square—Stoves for heating water
3171 W. E. Newton, Chancery Lane—Manufacturing syrup.—A com.
3172 J. Sherman, Whitechapel—Finger-rings
3173 C. Churchill, Norwood—Breech-loading fire-arms.—A com.
3174 J. Ashcroft, New York—Safety valves for locomotives
3175 A. Denarjrouze, Paris—Helmets
3176 J. Phillips, Hampstead—Warming buildings

17th October, 1868.

3177 E. T. Hughes, Chancery Lane—Adhesive substances.—A com.
3178 C. Mayer, Fleet Street—Tourists' bottles
3179 D. Wilson, Dundee—Brake for the wheels of vehicles
3180 A. Deshonnet, Brussels—Lighting apparatus
3181 W. T. Richard, Threadneedle Street, and W. C. Paul, Moorgate Street—Washing ores
3182 E. Ludlow, Birmingham—Central-fire cartridges for breech loading fire-arms
3183 H. Bunning, New Cross—Burning combustible liquids in furnaces
3184 F. P. Warren, Lee—Cooking apparatus
3185 R. A. Green, Strand—Treating folded paper sheets

19th October, 1868.

3186 T. Wrigley and W. E. Yates, Manchester—Beaming warps
3187 T. Wrigley and J. Richardson, Manchester—Looms for weaving
3188 J. Cockshoot and H. Weatherill, Manchester—Carriage axles
3189 B. Hunt, Lincoln's Inn—Scissors.—A com.
3190 A. M. Clark, Chancery Lane—Submarine telescopic lantern.—A com.
3191 C. Whitehouse, Cannock—Manufacturing augers
3192 W. E. Newton, Chancery Lane—Gun barrels.—A com.
3193 W. H. Howes, Shoreditch—Swing windows
3194 W. R. Lake, Chancery Lane—Preparing fish.—A com.
3195 J. Rae, Sydenham—Refuse carts
3196 W. Fitch, Washington City—Carriages for ordnance.—A com.

20th October, 1868.

3197 W. Dore and J. Thornhill, Manchester—Motive-power engines
3198 H. A. Bonneville, Piccadilly—Safety lamps.—A com.
3199 J. Elce, Manchester—Mules for spinning
3200 J. A. Farrar and B. R. Huntley, Hartlepool—Cabins of ships
3201 G. Voigt, Cabir—Railway breaks
3202 C. Lauenstein, Manchester—Purifying paraffine.—A com.
3203 G. Chapman, Glasgow—Treating sewage
3204 E. T. Hughes, Chancery Lane—Tea and coffee pots.—A com.
3205 E. Harrison, Newhaven—Mills
3206 J. Sykes and G. Malin, High Holborn—Preparing carriages for receiving colour
3207 J. Lorkin, Norwood—Tobacco pipes
3208 E. T. Hughes, Chancery Lane—Polishing needles.—A com.
3209 D. and A. Posener, Goodman's Fields, and M. Unger, Aldgate—Holders for glass shades
3210 J. F. Brinjes, Whitechapel—Centrifugal machinery
3211 J. H. Johnson, Lincoln's Inn Fields—Boots and shoes.—A com.
3212 J. M. Brierley, Milk Street, and E. C. Vine, Bunhill Row—Fastenings for stays
3213 W. Maudslay and W. C. Rawlins, Liverpool—Furnaces
3214 J. Westwood, Bow Road—Socket joints for metal piles
3215 T. Forster, Streatham, and J. Heartfield, Thornton Heath—Bath gloves

21st October, 1868.

3216 J. Stafford, Somers Town—Chimney terminals
3217 J. J. Parkes, Paddington—Cooking and heating stoves
3218 C. Shaw, Sheffield—Propelling vessels
3219 J. Holden, Keighley—Combing wool
3220 H. Clifton, New Bond Street—Butter churns
3221 J. H. Johnson, Lincoln's Inn Fields—Bobbins.—A com.
3222 T. Richards and C. H. Carter, Birmingham—Extractors for breech-loading pistols
3223 H. C. E. Malet, New Bond Street—Projectiles
3224 E. O. W. Whitehouse, Stoke Newington—Protecting telegraph wires
3225 H. Warner, Old Jewry Chambers—Mowing machines
3226 C. MacMillan, Sunderland—Protecting iron ships from corrosion.—A com.
3227 W. K. Foster, Massachusetts—Carriage wheels

22nd October, 1868.

3228 F. Bennett and R. Ward, New Broad Street—Capturing whales.—Partly a com.
3229 K. J. Winslow, Twickenham—Rotary motion
3230 M. A. F. Mennons, Newgate Street—Engine for raising water.—A com.
3231 J. Ryder, Manchester—Kilns
3232 C. Akrill, West Ham—Burning creosote
3233 G. T. Bousfield, Brixton—Propelling water craft.—A com.
3234 C. D. Abel, Chancery Lane—Railway rolling stock.—A com.
3235 T. Carr, Bristol—Pulverizing minerals

23rd October, 1868.

3236 W. T. Carrington, Westminster, H. Gielgud and Z. L. Wessely, George Yard—Breech-loading fire-arms
3237 A. B. Bérard, Paris—Converting cast iron into steel
3238 R. Dowling, Exeter—Bottles for containing poisons
3239 T. Walker, Birmingham—Fastenings for scarfs
3240 J. Birch, Newton Heath—Casting Bessemer steel ingots
3241 W. W. Tonkin, Kingsland—Valves for engines
3242 J. De Redon and T. Faucheux, Kentish Road—Cigars and cigarettes
3243 J. Gregson and W. Monk, Preston—Looms for weaving
3244 M. Sautter, Paris—Preparing wool.—A com.

3245 M. Santter, Paris—Preparing fibre from bamboo.—A com.
3246 C. B. James, Redditch—Needle-cases
3247 J. Bernard, Strand—Dressing ores

24th October, 1868.

3248 J. Baggs, High Holborn—Smelting iron
3249 J. Anderson, Ballymacarrett—Manufacturing felts
3250 J. Spratt, High Holborn—Food for horses
3251 B. Hunt, Lincoln's Inn—Power capstans.—A com.
3252 R. S. Burn, Manchester, and E. S. Eyland, Bristol—Conservatories
3253 C. W. Davis, King Edward Street—Paper collars
3254 G. Nurse, Westphalia—Coating metals
3255 E. Wimbridge, Great James Street—Blocks for surface printing
3256 A. Giraud, Gray's Inn Road—Separating silver from argentiferous lead
3257 W. Reid, Granton—Cattle waggons
3258 W. G. James, Queen's Square—Propelling
3259 S. Clarke, Rye—Cleaning cotton.—Partly a com.
3260 H. E. Newton, Chancery Lane—Steam-pumps.—A com.
3261 H. Mayhew, Bloomsbury—Button fastening
3262 W. E. Gedge, Strand—Glove fastening.—A com.
3263 J. L. Kieffer, Mark Lane—Sewing machines
3264 E. A. Rippingille, Holborn Hill—Obtaining motive-power
3265 J. Silvester, West Bromwich—Steam-gauges
3266 W. Dawes, Leeds—Pulley block

26th October, 1868.

3267 P. M. Crane, Manchester—Dressing cotton yarns
3268 W. Heasler, Greenwich—Coating wire with india-rubber
3269 B. Nicoll, Regent Street—Plastic composition for ornamenting walls
3270 C. Harrison and R. Wilson, Manchester—Indicating temperature
3271 J. Loader and W. H. Child, Finsbury—Rotary engines
3272 W. A. Lyttle, London—Electro-telegraphic instruments
3273 W. E. Gedge, Strand—Gas burner.—A com.
3274 W. Boulton, Burslem—Manufacturing oval-shaped articles of pottery
3275 J. Jones, Stratford, and S. P. Bidder, Mitcham—Breaking coal
3276 T. Speight and W. H. France, Bradford—Wool-combing machines
3277 T. Priestley and W. Deighton, Bradford—Looms for weaving
3278 W. Mort, Fenchurch Street—Reducing temperature
2279 F. Ransome, Southwark Bridge—Preserving stone
3280 A. M. Clark, Chancery Lane—Scouring wool.—A com.

27th October, 1868.

3281 W. E. Gedge, Strand—Manufacturing salignons.—A com.
3282 A. H. Smith, Clifton—Gas-heating apparatus
3283 G. Zanni, Ironmonger Lane—Telegraph-printing instruments
3284 W. E. Hickling, Spittlegate—Cask-washing machinery
3285 J. Little, Glasgow—Glass furnaces
3286 J. B. O'Hea, Greenwich, and W. Bullen, Brixton—Breech-loading fire-arms
3287 G. Fajen, Kentish Town—Ventilators
3288 W. D Young, Edinburgh—Roofing houses
3289 J. Wallace, Glasgow—Dentistry
3290 E. T. V. Hecke, Paris—Locomotive engines
3291 J. Johnson, Westminster—Window frames

28th October, 1868.

3292 T. Mordue, Newcastle-upon-Tyne—Steam-boilers for marine engines
3293 R. Hamilton, Lesmahagow—Railway chairs
3294 H J. Sanders, Brighouse—Regulating the flow of liquids
3295 J. Moran, Dublin—Boots and shoes
3296 M. A. Soul, Flusbury Place—Railways.—A com.
3297 C. E. Brooman, Fleet Street—Steam-engines.—A com.
3298 A. Wilson, Barrow-in-Furness—Metallic moulds
3299 W. Dawes, Leeds—Pianofortes
3300 G. E. Donisthorpe, Leeds—Packing the pistons of engines
3301 P. B. Cow and J. Hill, Cheapside—Tooth-brushes
3302 C. Kelson, Lombard Street—Horse collars.—A com.
3303 W. Prowett, Gillingham—Knitting machines
3304 J. G. Tongue, Chancery Lane—Fire-signals.—A com.

29th October, 1868.

3305 M. Benson, Manchester Square—Shaft couplings.—A com.
3306 B. Dobson and J. Clough, Bolton—Preparing cotton
3307 R. Meldrum, Cupar—Utilizing waste steam
3308 F. A. Blanchon, Paris—Tops
3309 W. H. Liddell, Edinburgh—Treating pig skins
3310 G. and J. White, Glasgow—Looms for weaving
3311 W. Scott, Leeds—Drying wool
3312 J. Adams, Barnsbury, and W. Adams, Islington—Bricks and tiles
3313 J. Heaton, Langley Mills—Iron and steel
3314 H. Walworth, Manchester—Taps or valves
3315 R. Oxland, Plymouth—Treating ores

30th October, 1868.

3316 W. Brown, Smethwick—Rolling metals
3317 A. S. Paterson, Bridge of Allan—Heels for boots
3318 W. Collins, Glasgow—Separating paper
3319 J. Wright, Sheffield—Portable printing presses
3320 G. Allix, Southampton—Lowering ships' boats
3321 S. Sharrock, Liverpool—Lamp-posts
3322 W. E. Dando, Manchester—Mourning hats
3323 R. Irvine, Leith—Producing alcoholic liquors

31st October, 1868.

3324 J. Bronner, Frankfort-on the-Maine—Gas shades
3325 W. E. Bates and T. Dodd, Northwich—Nut-cracking apparatus
3326 A. M. Clark, Chancery Lane—Sewing machines.—A com.
3327 J. Langford, Birmingham—Teapot handles
3328 B. Dickinson, Darjelling—Propelling ships
3329 S. A. Varley, Holloway—Generating static electricity
3330 A. Munro, Arbroath, and W. B. Adamson, Glasgow—Manufacturing tools

2nd November, 1868.

3331 S. Ault, Cannock—Plastering trowels
3332 J. Lodge, Leeds—Looms for weaving
3333 T. T. Labitte, Paris—Advertising
3334 J. Dannatt and T. S. Turnbull, Sunderland—Saving life at sea
3335 J. Vavasseur, Southwark—Discharging ordnance
3336 J. H. Bertie, Nottingham—Twist lace machines

3rd November, 1868.

3337 J. Moore, Manchester—Woven fabrics
3338 L. Berenger, Paris—Ironing machine
3339 J. A. R. Main, Glasgow—Iron sheds
3340 E. Barton, Victoria Park—Scarfs
3341 S. Schuman, Glasgow—Treating fœcal matters
3342 B. Johnson, Chester—Torsion springs.—A com.
3343 G. F. Morant, Frenchay—Cases for packing game

4th November, 1868.

3344 W. R. Lake, Chancery Lane—Low-water alarm for steam-boilers.—A com.
3345 R. W. Beckley, Ludgate Street—Pen-rest
3346 M. Samuelson, Hull—Manufacturing oil cake
3347 E. Holden, Leeds—Preparing wool
3348 A. V. Newton, Chancery Lane—Atmospheric water-elevating engines.—A com.
3349 E. T. Hughes, Chancery Lane—Manufacturing furred fabrics.—A com.
3350 J. W. and J. Holt, and J. Maude, Bolton—Spinning and doubling
3351 J. B. Houghton, Parliament Street—Umbrella holders
3352 M. Sautter, Paris—Preserving vegetable substances.—A com.

5th November, 1868.

3353 S. Ward, W. Hurst, and J. Tuer, Farnworth—Looms for weaving
3354 T. Burt, Wandsworth Road—Dredgers.—A com.
3355 H. Jewitt, Kentish Town—Toys.—A com.
3356 T. Robinson. Widnes—Iron and steel
3357 R. Cook, Sheffield—Spinning and twisting
3358 R. Needham, Dukinfield—Scrapers for steam generators
3359 B. Hunt, Serle Street—Electro-physiological batteries.—A com.
3360 J. Clark, Kendal—Turning bobbins
3361 A. Reid, Arbroath—Rolling tobacco
3362 J. Corbett, Clerkenwell—Railway carriages
3363 A. L. Bricknell, Stratford-upon-Avon—Rotary engine pumps
3364 J. Edwards, Hackney—Harness
3365 W. R. Lake, Chancery Lane—Boot soles.—A com.

6th November, 1868.

3366 A H. Robinson, Dublin—Cocks or taps
3367 C. Archer, Holloway Road—Manufacturing cigars
3368 J. H. Johnson, Lincoln's Inn Fields—Preparing pigments.—A com.
3369 T. Lucas, Barnes, and T. P. Lucas, Bromley Manufacturing locks
3370 J. Samuel, Westminster—Locomotive steam-carriages
3371 J. Taylor, Wigan—Steam boilers
3372 J. Parrott and W. Jones, Salford—Beetling woven fabrics
3373 F. C. Philippson, Salisbury Square—Fire-engines
3374 F. C. Martineau, Birmingham—Door hasps
3375 T. Harrison, Liverpool—Pianofortes
3376 W. Baker, Wigan—Furnaces
3377 M. A. F. Mennons, Newgate Street—Forming screw threads on bolts.—A com.
3378 W. Irmer, Clerkenwell—Corn-flour jelly
3379 W. Broughton, Finsbury Market—Kitchen ranges
3380 A. M. Clark, Chancery Lane—Manufacturing ropes.—A com.

7th November, 1868.

3381 J. C. Haddan, Westminster—Cannon wads
3382 S. Arnott, Holloway—Braces
3383 J. Lewthwaite, Woburn Place—Boring rock
3384 M. B. Westhead, Manchester, and C. B. James, Redditch—Packing needles
3385 H. Steffanson, Brompton—Buffers
3386 J. Macneill, Kensington—Stamping letters
3387 J. H. Johnson, Lincoln's Inn Fields—Cutting screw threads.—A com.
3388 J. Sturrock, Glasgow—Metallic caps for bottles
3389 A. M. Clark—Chancery Lane—Planing wood.—A com.
3390 A. M. Clark, Chancery Lane—Separating liquids from solids.—A com.
3391 W. J. Criddle, Truro—Washing linen
3392 W. Corden, Datchet—Lamp globes
3393 G. T. Bousfield, Brixton—Barring soap.—A com.

9th November, 1868.

3394 N. Wilson, Holborn—Sewing Machines
3395 H. Davis, Birmingham—Combined tobacco dish and cigar rack
3396 W. Manwaring, Banbury—Reaping machines
3397 R. M'Hardy, Edinburgh—Hoeing machines
3398 B Hunt, Serle Street—Woven fabrics.—A com.
3399 W. M. Brown, Paris—Raising and lowering apparatus
3400 P. E. De Wissocq. Paris—Treating lead ores
3401 W. R. Lake, Chancery Lane—Door knobs.—A com.
3402 J. L. L. Sweatuam, Lougton—Brick kilns

10th November, 1868.

3403 H. L. Beunison, Greenwich—Rotary engine and pump
3404 L. A. Israel, Minories—Manufacturing sulphuric acid
3405 T. Rose, Oxton, and R. E. Gibson, New Brighton—Utilizing waste material
3406 P. B. Tyler, Paris—Connecting rails on railways
3407 J. H. Johnson, Lincoln's Inn Fields—Utilizing heat.—A com.
3408 G. Clark, Strand—Manufacturing explosive compounds
3409 J. Hine, Cockermouth—Dressing millstones
3410 C. E. and T. C. Winby, Cardiff—Preventing collisions on railways
3411 J. H. Wilson, Liverpool—Water closets
3412 J. Gregory, Bristol—Retorts for charring bones
3413 W. H. Hall and J. Cooke, Birmingham—Safety lamps
3414 T. Cain, Douglas—Treating potatoes
3415 J. Hickisson, Hackney—Pencils
3416 C. G. Abbott, Harrowgate—Distributing sewage water
3417 W. Riddle, Larkhall Lane—Hooping bales
3418 T. R. Crampton, Westminster—Furnaces
3419 H. Bessemer, Cannon Street—Iron and steel

11th November, 1868.

3420 T. Vaughan and E. Watteeu, Middlesborough-on-Teea—Screw bolts
3421 E. and F. Dixon, St. Marylebone—Packing bottles
3422 R. Halliday, Worsley—Oiling waggon axle
3423 E. Madge, Swansea—Manufacturing tin
3424 W. S. Thomson, Cheapside—Manufacturing jackets
3425 M. H. Davies, Liverpool—Constructing fences
3426 G. and J. Wilson, Hanley—Brick kilns
3427 F. Holmes, Romford—Smoking pipes
3428 G. Piercy, Halifax—Carriages
3429 J. Lewthwaite, Bury—Wood-shaping machinery
3430 A. M. Clark, Chancery Lane—Printing machines.—A com.

12th November, 1868.

3431 C. J. Chaplin, Bucklersbury—Cattle food.—A com.
3432 S. and G. Holt, Bacup—Manufacturing pickers
3433 H. Henkel, Upper Thames Street—Breech-loading fire-arms.—A com.
3434 A. A. Hely, Stratford—Umbrellas
3435 T. B. Collingwood, Rochdale, and W. Hardman, Bolton—Spindles
3436 P. J. Livsey, Manchester—Sewing machines.—A com.
3437 D. Griffiths, Bradford—Timber bearers for roofs
3438 W. R. Griffiths, Bristol—Steam-boilers
3439 L. Wray, Ramsgate—Grinding quartz
3440 E. Haas, Mark Lane—Sewing machines
3441 W. Donisthorpe, Cambridge—Getting coal
3442 G. P. White, Furnival's Inn—Screw piles
3443 J. Kellow, Tremadoc—Rock-cutting machinery

January. 1869.
Practical Mechanics Journal.
Plate II.

Third Series.
Vol. 4.

GREAT MELBOURNE TELESCOPE.

Constructed by

THOMAS GRUBB, ESQ. F.R.S.

Fig. 10.

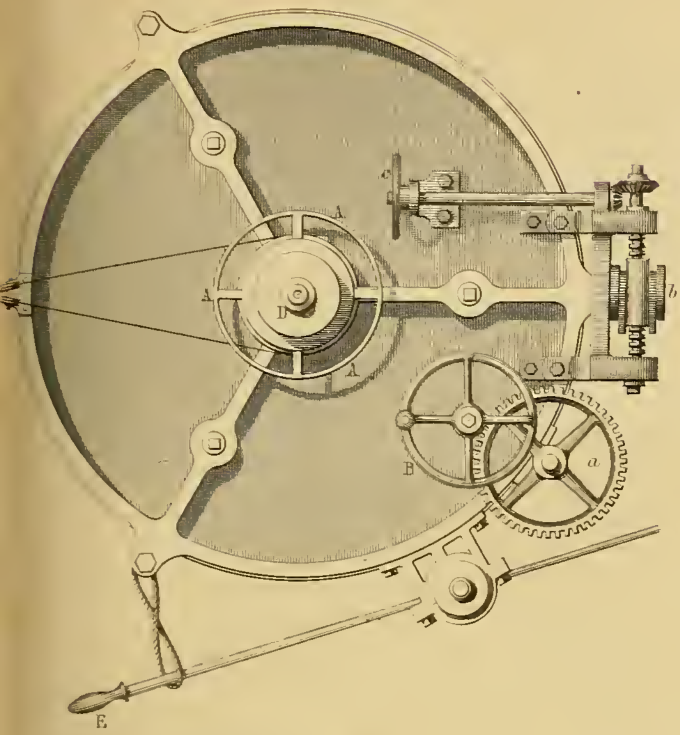


Fig. 11.

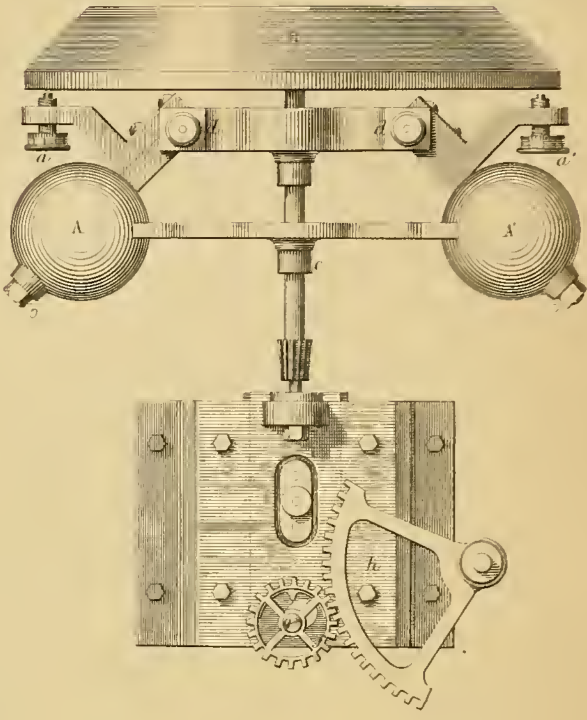


Fig. 5.

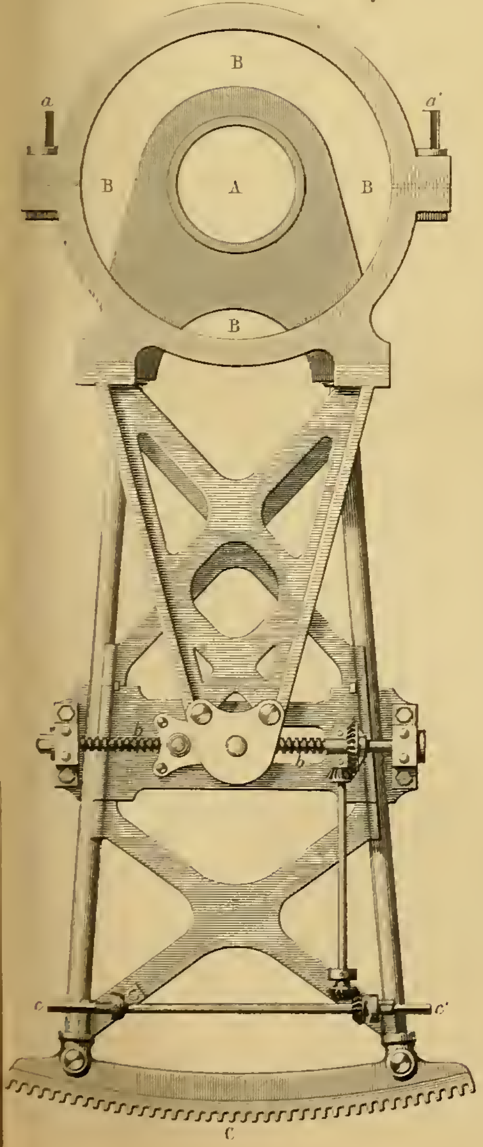
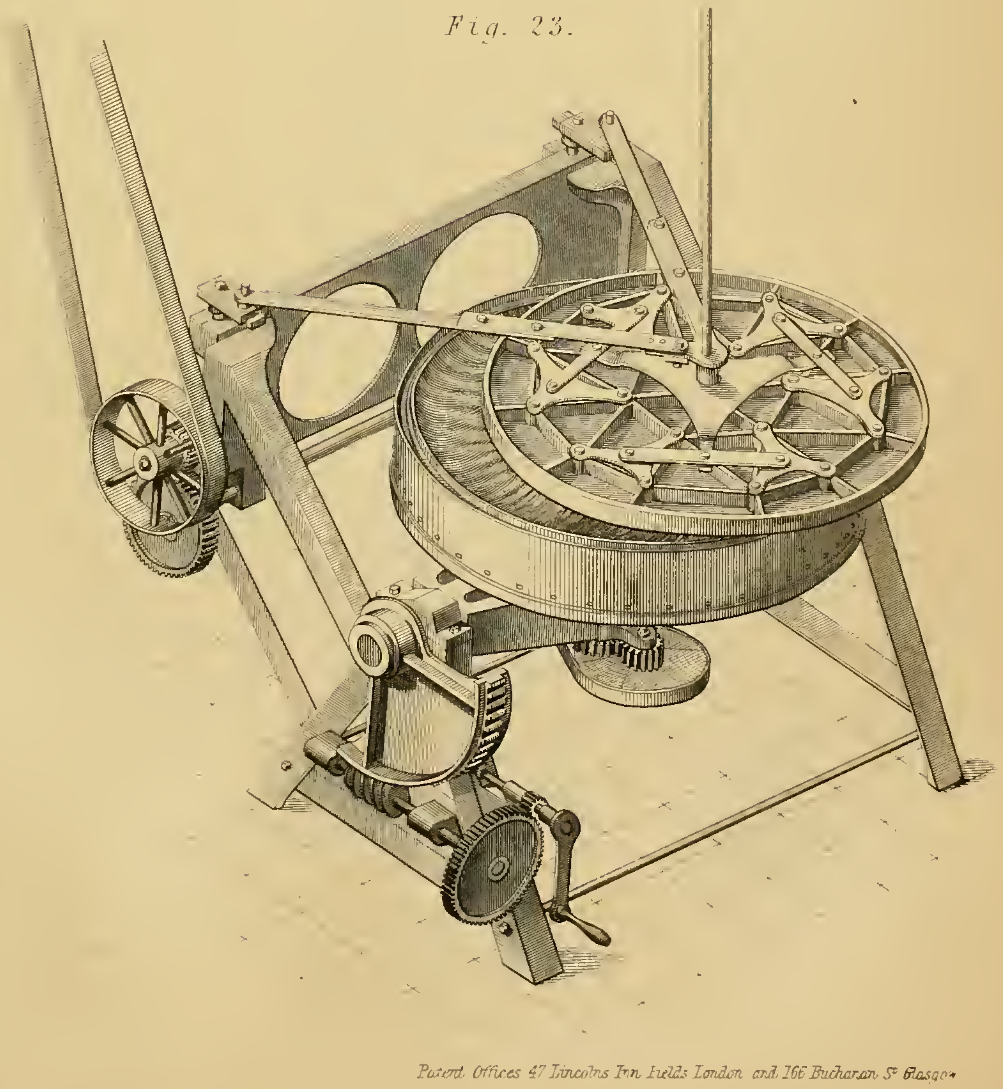


Fig. 23.



Patent Offices 47 Lincolns Inn Fields London and 166 Buchanan St Glasgow

DIRECT ACTION STEAM PUMP.

WILLIAM TIJOU, C.E.
Patentee

Fig. 1

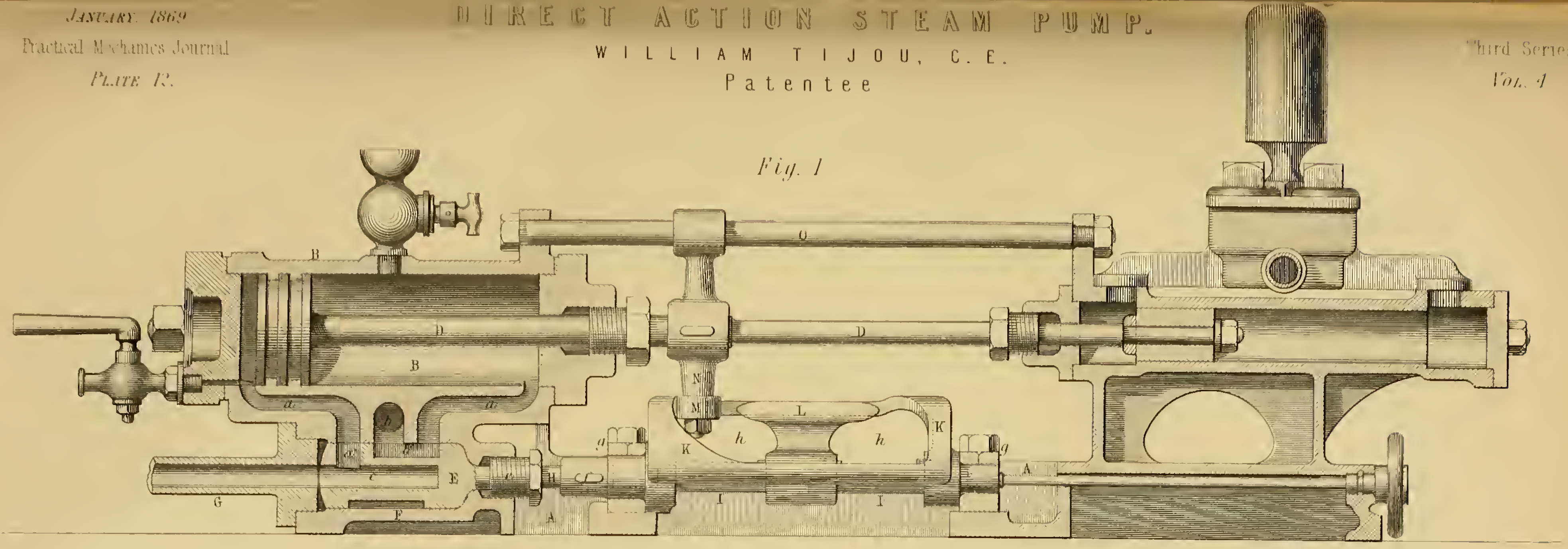


Fig. 2.

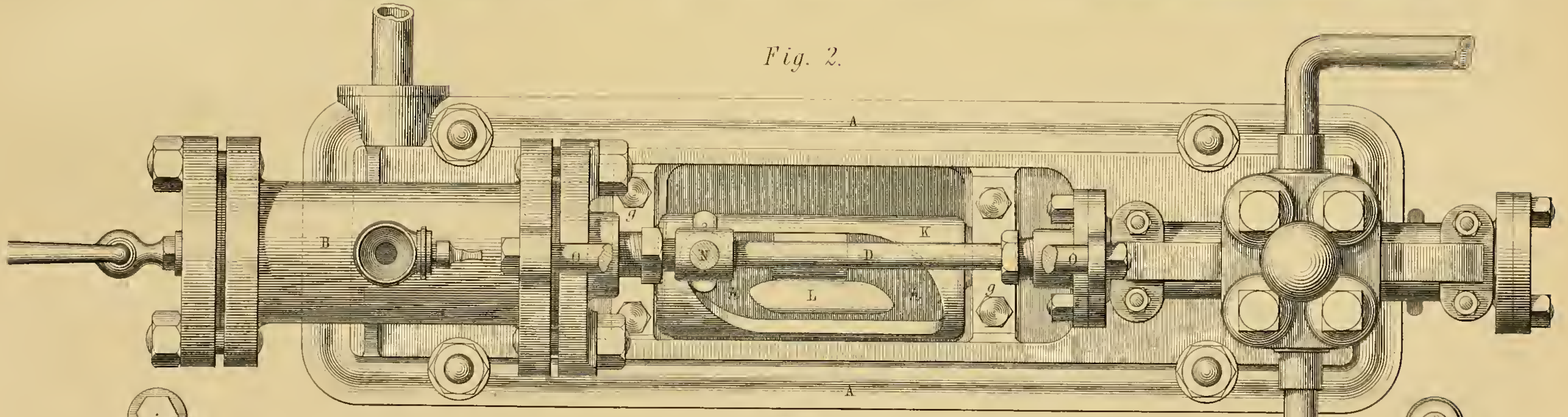


Fig. 3.

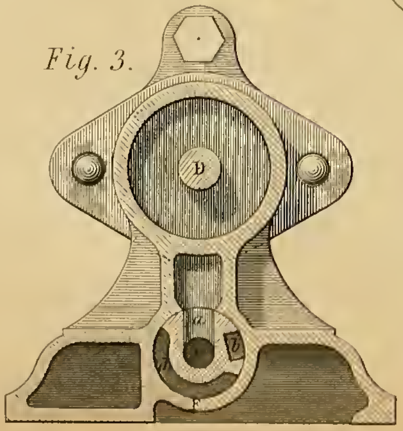


Fig. 4.

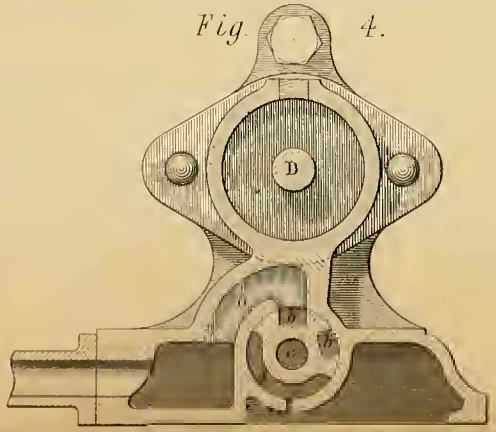
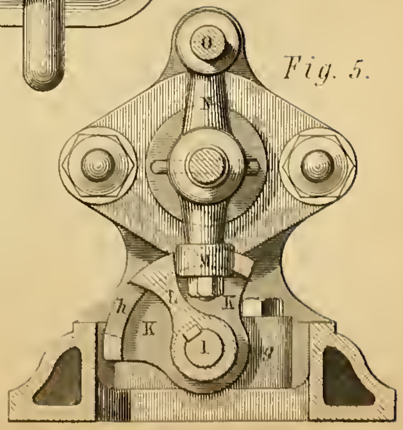


Fig. 5.



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THE CLOSE OF THE YEAR.—THE PRESENT AND FUTURE OF ENGINEERING.

The gloom and inaction that saddened the commencement of the year now at its close, and had continued for so many months before, and is not even yet dispelled, though breaks in the clouds that are nearest the ground are already here and there visible, marks, there can be but little doubt, a great epoch in the civil engineering of Great Britain, Europe, and indeed of the civilized world. It is not, as some would say, that the *æon* of comparatively small and minor work is done—that Europe is now netted over with railways, dotted with works and factories, everything done by machinery that machinery nearly can do; for that is all to take a false and insufficient view of the nature and springs of human progress, whose reservoirs are exhaustless, and from which new and unexpected streams of industry are for ever issuing forth beneath the wand of genius and discovery; but that the grander *æon* has opened for engineering when in reality every valley shall be exalted, every mountain made to bow, the rough places made smooth, so that men may run to and fro in the earth, even to its very ends and bounds.

The very means that have been evoked during the last seventy-five years, or perhaps a little more, by which all this relatively minuter, though yet great iron net weaving, and factory dotting, have been effected, have shown men the means and the way to deal with projects for the overcoming of natural forces and obstacles, of a sort and upon a scale that only fifty years ago men dreamt about, but never seriously contemplated as practicable, far less set about in earnest to perform. The epoch of giant engineering works in improving the world has really arrived; and what the issues may, or rather must be, in very various ways, upon the future destinies of nations, of dynasties, of the localizations of commerce, the aggregations of wealth, the obliteration of the old in many things, the impress of the new upon all, he would be a more bold than wise man who should undertake to limit or even to predict. With certainty only can we say, that upon the whole, the upshot to the human race at large of those immense works in progress or in prospect, for making straight the highways of the world and finding paths where there were none before, whether through mountain crests or upon or beneath the deep, must be for the advancement, benefit, and increased happiness of mankind.

The Suez Canal—after years of labour and perseverance against every obstacle and discouragement, enough alone to immortalize the names of Lesseps and those who have, like his able contractors Lavallé and Borell, stood staunchly by him through every difficulty—at last begins to prove itself to the world at large, and even to the most incredulous eye, as about at an early period to be accomplished. In fact, in some senses, it is so already. The Sweet Water Canal has already conferred great agricultural benefits upon the country through which it passes, and must prove hereafter a source of uncountable riches to Egypt, and of great revenue to the canal company. The English engineer who showed himself, as regards this Suez Canal question, the only competent one—for Mr. John Hawkshaw, in his able report, boldly stated that it was not only practicable but easy to construct, and that the dogmata of Robert Stephenson as to the impossibility of keeping it open were purely chimerical—has stated, that he would undertake to irrigate the whole land of Egypt, *i.e.*, all its tillable land, from that canal.

A condition produced by the relations of the salt water or great ship canal and the arid climate of Egypt, which Stephenson never thought of, has since been carefully taken into account, and it is now certain that whenever the sea shall be let into and fill the Bitter Lakes, the evaporation from the water surface alone will be such as to cause a considerable current through the canal, which, according to Stephenson, would be "no more than a stagnant ditch;" indeed, the question has been raised whether the scour due to this cause and to alternate action of the tides, though these are small at either end, may not prove more than desirable. The effect, however, of this evaporation will unquestionably be to totally and rapidly change the whole climate of Egypt, so that, irrespective of any irrigation, it will probably become sufficiently moist to gradually put an end to the Egyptian Sahara, through the unseen working of the forces of nature. Should this even in a minor degree be realized, and there can be little doubt upon the subject, it will be probably the most wonderful result in the modifying of cosmical forces as found in nature ever achieved by human means.

England has all along occupied a most unenviable and unfortunate position as regards this grand project, of which France may be so justly proud, and the completion of which we hope the Emperor may live to see, and to know that it will be one of the events by which history will mark his reign. But we will not go back upon the unpleasant track of misjudged policy, mainly due to Lord Palmerston's political prejudices as to Eastern affairs, sustained by R. Stephenson's engineering misjudgment, in which the facts and deductions were fitted for the political foregone conclusion, rather than to nature and reality. The recent tardy sort of half retractation of ancient opposition and prejudice on the part of the *Times*, and some other English leaders of opinion, is but a pitiful display of grudgingly admitted error and half-given praise. The old story, "it will never pay," however, is still raised, but no attempt is made upon any solid and sensible basis of figures, in Great Britain at least, to prove that that is so. The Dutch government has proved itself very much before our own in intelligence and appreciation of this grand work. They have formed a commission to investigate—with a view to the future effects of the canal when opened upon their own possessions, Java, &c., in the East—the question of whether it will pay or not; and, as the basis to that, have endeavoured to estimate what will be the probable amount of maritime traffic through the canal. They rightly at once view the Red Sea as only a prolongation of the canal, and admit that the navigation of both must be one of steam towage. For the performance of this, no doubt some great mercantile combination will be formed in the shape of a steam towing company, who will take in convoys the ships in tow at Port Said, and at the eastern end or mouth of the Red Sea respectively. The particulars of this report, though known in England, have not yet been published, we believe, here.

For some years after 1870, about which time probably we may date the effective completion of the canal, it is highly probable it may fall far short of paying even a very moderate interest on the capital expended; but its traffic will, in our judgment, rapidly expand, and before twenty or thirty years shall have elapsed we believe it will have greatly changed the route of merchandise to and from the East, and certainly have become the highway of the nations as to travelling. The fears entertained about the formidable strategic uses of the Suez Canal, and the hostility of France, &c., are as chimerical as those about the natural obstacles to its formation. Whoever holds the land of Egypt commands the canal. France must not be let to hold it, nor any other European nation, but free way secured for all the world by treaty. But in the event of war, should such a lamentable piece of mischief become necessary, the canal can be destroyed and blocked up even by a temporary invasion of a few days, or without any operations by land at all, and so the communication between the seas severed as easily as a piece of packthread is broken. Its existence, in place of evil however, is for nought but good to England, either in peace or war.

Though a remote work, and one for probably the next century, the natural *sequitur* to the Suez Canal will probably be the revival and realization in some way of the grand project of Louis XIV.'s time, for forming an interoceanic canal and river navigation through France, to connect the Atlantic and German Oceans with the Mediterranean. The Rhine, the Moselle, and the Rhone, together with the Loire, may yet be made the basis of this vast navigation, by which the commercial marine, as well as the rich products of Northern and of Central Europe, should reach the Mediterranean; and the products of the East, coming through the Suez Canal, reach the North and West without passing round the great Iberian peninsula or traversing the Bay of Biscay.

The Mont Cenis Tunnel has reached the position when its day of completion can be almost calculated, though we are much disposed to believe that the Paris correspondent of the *Times* was much more nearly correct than a sciolist pretender to engineering knowledge who contradicted him with great flippancy in the pages of that paper, and that it will be misleading to calculate upon the time of completion by direct deduction from the daily average rate of progress of perforation at *both* headings. We cannot spare space here to develope fully our reasons for this view; but those who are *really acquainted* with and accustomed to great geodetic operations, will easily discern the large number and the *cumulative* nature of the errors of assigned relative position of the two ends of the tunnel, and see that at the very least great caution and great uncertainty as to the mid mountain junction of the two headings exist; so that probably when nearing a close, it may be necessary to proceed by tentative operations, and in the end possibly, though we trust not probably, to modify the direction and introduce curves or altered gradients into the junction or mid length of tunnel.

Meanwhile, no less than three other great tunnels are projected through the Alps, and one of these projects has reached even the first stage towards accomplishment, by having asked the capital necessary for the execution of the work.

In the *Revue Moderne* for the 25th October of this year (1868) there is a remarkable article from the pen of M. Eugene Flachat, C.E., the president of the Society of Civil Engineers of France, entitled *La Suisse et les Communications Transalpines*, in which the future of the passages for northern and western Europe, across the Alps and into Italy, is discussed at some length. The article is remarkable in more than one respect. It certainly possesses much of the characteristics of one of those unacknowledged state feelers, such as the present government of France is accustomed to put forth at intervals in order at once to ascertain and to direct the state of the political atmosphere. If this be so, it would seem to indicate that France seriously looks to the absorption, before many years pass, of the whole of Switzerland.

After pointing out the daring rapidity with which all the rest of Europe has been furrowed by lines of railway, and shown that the territory of the Swiss Confederation is far behind the rest of the Continent in this respect as in others, rather overstating perhaps the truth in saying that Switzerland is, in respect of its railway communications, below the level of Spain or Russia, the writer continues :—" Swiss neutrality has always been passive. If a chain of mountains may constitute a frontier, a group of mountains form a fortress, the possession of which opens the frontiers which surround it." . . . . " Whenever a day shall come that there shall arise between Switzerland and one of the neighbouring states one of those longings for revenge, one of those rivalries which pierce deeply the heart of nations after great reverses in their military affairs, Switzerland will be lost." . . . . " On that day Switzerland will become Germany."

After drawing a very unfavourable picture of the state of civilization of the cantons, and an equally unfavourable but certainly very true picture of the paucity of its railway communications, and the incapability of the existing communal institutions of the country to provide better, as well as the unpaying characteristics of the lines which exist, he proceeds to sketch out what he affirms should be done in the way of improved communication :—" Three great railway lines ought to be opened across the Alps ; viz., by the Lukmanier, the St. Gothard, and the Simplon passes." While France is most interested in that of the Simplon, Germany is most so in Lukmanier. Switzerland is hostile to any line over the Simplon, because of its jealousy of France. Italy hails with pleasure any or all of them, having no choice except for whatever line shall enrich her most.

M. Flachat passes in rapid review what has been accomplished at the tunnelling of Mont Cenis, which may be averaged now at 1·90 metres per day for each face of heading, or very nearly 4 metres per day advance of the tunnel, and sketches with a masterly hand the improvements in the rate of machine tunnelling that may be yet made. We are not by any means convinced, however, that he is right in his views that the machine of Captain Penrice is to be preferred for the future to those of Sommeiller and Grandi; or that because Penrice's machine has been shown to cut a trepan cylinder of 1·65 metre diameter at the mean rate per *hour* of 1·60 metre, in soft limestone, that therefore it can cut into granite at the rate of from 15 to 20 centimetres per hour, or in the inverse ratio of the hardness of these rocks. On the contrary, we doubt much that Penrice's machine must prove a total failure in granite or any like hard siliceous rock. However, his general conclusion admits of no doubt—namely, that tunnelling in the Alps, upon a scale such as these and like vast ranges of mountains demand, is a matter of certainty now as to success, economy, and amount of cost, and that hence huge tunnels ought no longer to oppose the progress of the engineer in opening out such mountain barriers.

The Mont Cenis tunnel will be, when completed, 12,220 metres in length. That needful for the other Alpine lines which he has indicated, would be as follows :—

For the Simplon, ...	12,080 metres of tunnel.
" St. Gothard, ...	15,480 "
" Lukmanier, ...	1,710 "

And the summits above sea level :—

Mont Cenis, ...	1,200 metres.
Simplon, ...	1,300 "
St. Gothard, ...	1,110 "
Lukmanier, ...	1,750 "

The Mont Cenis tunnel has cost about 5000 francs per metre forward, not including interest on the outlay, so that the tunnelling of the Simplon would need a capital of 60,000,000 of francs, and that of the St. Gothard of 78,000,000. He estimates the capital required for each of the three lines to be as follows :—

	Francs.
For the Simplon—between Brieg and Isola, . .	80,000,000
For St. Gothard—between Amstegg and Biasca, .	125,000,000
For Lukmanier—between Dissentis and Biasca, .	52,000,000
Total, ...	257,000,000

This is without reckoning for the approach lines on Swiss territory, which he further calculates in detail.

Without going through his figures, which are probably far from conjectural—for it is to be remembered that the St. Gothard line, at least, was surveyed and laid out in detail some years ago—he arrives at the conclusion that the total cost of establishing the three great lines of passage, and placing them in full communication with the railway systems of the countries to the north and south of the Alps, would reach a total cost of 387,800,000 francs, or £15,512,000.

He then discusses the steep incline system of railways, of which the great existing lines over the Alps, of the Sömmering and the Brenner, are examples, and fully admits the validity and value of Fell's system, into which he enters at some length, and with some physical data, which, as expressed at least, we confess we do not fully comprehend. He then broaches the recommendation of establishing Fell railways, in the first instance at least, over the three lines, at a total cost represented by 41,000,000 of francs—a capital which he thinks not too much to be guaranteed by the cantons, by an interest limited to 600,000 francs per passage or way, at maximum, and an annuity to return the capital in twenty years. He then returns to consider the social and political difficulties to this, or to any project, which the poverty, ignorance, and mental sloth of Switzerland as a whole, the mutual jealousies of the cantons, and the surrounding national rivalries present; and finally comes to this comforting assurance for them, that if the Swiss cannot or will not effect these passages for themselves, and so, by the effort, really save and insure for futurity their national or republican independence, other European nations, *i.e.*, France of course, must do it for them, and in the process, if that independence should be extinguished, why, so much the worse for it. This notion is fortified by a not overdrawn though severe picture of the waste of natural resources that always has been going on in the great Swiss valleys, such as that of the Rhone, by the incapability of the cantonal administrators to cope with the destructive natural agencies at work, in the way of torrents and detritus ever encroaching on arable land and destroying, not only the means and rewards of industry, but also the existing common roads of communication. The present winter's events are certainly a strong commentary, in the inundations on the Italian side, of the force of M. Flachat's remarks.

Whether we are to view this paper as, in part at least, having a political significance, or mainly as the opening out of a grand field for future work for French capitalists, engineers, and workmen, it is one of great ability, and in which a vast amount of information is put together with masterly lucidity and brevity. The main object of the article, however, can be no longer doubtful; for within a few weeks since its appearance the *Nouvelle Compagnie Anonyme des Chemins de Fer de la Ligne d'Italie par le Simplon* has been brought upon the *bourse* at Paris, the capital to be raised by " obligations," and under the sanction of a special law of concession to the company, which, it appears, was granted to them by the Swiss government in conformity with certain pre-existent formalities and laws, both Swiss and French, no longer ago than 4th September, 1868.

Perhaps it will be matter of no regret that England is thus getting rapidly shut out from these great enterprises in the very heart of Europe, although she, in reality, led the way to them all; for Bartlett originated machine tunnelling first with success, and Vignolles and Fell realized mid-rail Alpine rails and gripping locomotion. Our national work lies in a different quarter. Let us energize and waken up the Asiatic mind and heart, by covering India with a net of intercommunication, and spread irrigation water over the broad face of the thirsty land, so that famines shall be no more. So shall we really tighten, though unfelt and without gall or bitterness, our grip upon India, and be able to meet with power the future day, when we shall have to contend with Russia, either for our empire in the East, or for our permission that the Muscovite shall devour the Mussulman in Europe.

The Dover to Calais tunnel appears to approach the land of realities, too, as part of this vast system of intercommunication. A joint commission, acting on reports of Mr. Hawkshaw, has, we are informed, advised that the only possible step by which certainty can be obtained as to the practicability of a tunnel in the only practicable way yet proposed by any one, namely, that of an ordinary tunnel-lined excavation, made at a great and sufficient depth under the Straits of Dover, should be taken at the joint expense of the French and English governments. This is to endeavour to make, in the first instance, a drift way or little experimental tunnel along the intended line of the actual one. The capital needed for this, viewed as an affair for two such nations as France and England, would not be too large: it is admitted that it may be in part, possibly in great part, totally lost, and with it the lives of the men at one or other heading; but the object is a great one, and warrants a good deal of risk both of money and men.

Many projects, some very recently, have been broached, mainly by amateur engineers, for bridging the Dover Straits. In the mere mechanical sense this is certainly not impossible; but as regards the effect upon the navigation of the straits, especially at night, and upon the tidal stream, we believe any bridge may be put aside as really impracticably unadvisable. A far more feasible scheme is that of running out two very long moles from either shore, five miles perhaps each, with a sort of Ψ-shaped dock at the extremity of each, out of and into which, huge steam vessels should run, carrying the railway trains upon their decks, or rather in the interior of their hulls, upon a lower deck, and under cover. With a prodigious mass of rascality loose in the shape of *forçats* and convicts in both countries, it is hard to see why these moles should not be executed in effect without any cost to either nation, which must take care of these criminals whether idle or at work.

A vast ship of this sort, quite as long and broad as the *Great Eastern*, is at the present time seriously contemplated, if not something more, in the United States.

On the other side of the Atlantic also vast works are in progress, still vaster loom up quick upon the horizon of futurity. The greatest railway in the world, that which within two or three years, if not before, will rib across the northern continent of America and connect the Pacific and Atlantic sea-boards, passing over or through two mighty ranges of high mountains on the way, is progressing at the rate of *five or six miles per day*, it is credibly reported.

Rough, temporary, and dangerous in many ways it will be at first, and for some years; but yet, like the Panama Railway, it is certain to be traversed, and with traffic will come gradual improvement and amelioration of all sorts—a second line of rails, population and towns along its length, civilization, and, alas that it should be! the stern law of nature, the extermination of the Indian, unless he too will accept the law of progress, and, giving up his life of hunting, take to agriculture and steady labour of one sort or another. It will be to the West what Alpine tunnels, Italian railways, and the Suez Canal will be to the East.

The opening of the Suez Canal, and the success that we believe will prove itself in its use, will eventuate, ere another double decade shall have elapsed, in the reduction to more than a dream of some one of the many projects for cutting through the Isthmus of Panama. Nothing but an open cutting, if possible free of lockage, and of width to pass the largest ships by towage from the one ocean to the other, will, we are satisfied, be entertained whenever this great work comes to be seriously considered by practical men. Probably by the time this shall have arrived, experience as to the employment of power in every form of excavation, earth or rock, dry or under water, will have so far advanced, that the production of such a cutting will be deemed nothing mythical or appalling. We may also anticipate that the huge project, recently revived with some energy in the United States, of connecting the great northern lakes with the Mississippi, and so the internal navigation of the northern with the whole great river system of the southern states, will not be delayed even as long as a Darien Canal may be.

These grand works do not present a poor or gloomy view to the present or to the future generation of engineers and mechanicians, and to all who honourably live by "subduing the earth." If and when all these and more were done, the crop to be reaped will still be boundless; are there not yet two Continents, South America and Africa, practically untouched, a third, Australia, and we might say a fourth, in the great Polynesian Islands, all but untouched, by the hand of civilizing man?

It is indeed a sublime and a boundless prospect that the dominion already acquired by man over nature, through knowledge of her secret powers, presents to the speculative eye, and the heart that has not been compressed and chilled by theologic dogmas as to the future destinies of our race upon this globe of ours, may well glow in grateful anticipation of the ameliorations and exaltation in store through such means for man's estate.—Ed.

ON SOME POINTS OF PRACTICE IN IRON FOUNDING.

No. XXXIV.

MALLEABLE CASTINGS.

Having disposed of the theory of the malleableization of cast iron, so far as experimental knowledge to the present admits of that, it remains, to complete the subject, that we should say a few words as to the physical and constructive properties of the malleable cast iron itself, when the process has been, under the best conditions, conducted to completion. But, first, we will revert for a moment to the arguments adduced in our last article as to the true nature of the process, with a view to illustrate a little further one or two points.

We have attributed the increased flexibility of the annealed or malleableized cast iron to the uniform diffusion throughout its mass of minute crystalline scales of graphite. Some may doubt the possibility of this; but those who are accustomed to regard physical phenomena upon a broad scale, will at once call to mind a glaring instance of the way in which solids the most rigid may be rendered flexible by the uniform intercalation through their mass of fibrous or lamellar crystals of other bodies, which in themselves also when in larger masses are quite rigid. This is found in the well-known flexible sandstone of India. This consists of a mass of crystals of silex, or mainly silex, between which are uniformly intercalated fine fibrous crystals of amianthus or asbestus. Other flexible sandstone has been described, in which uniformly diffused scales of mica are thus found along with grains of quartz. The flexibility is due to the easy intermobility of these fine slippery crystals upon and amongst each other.

Itacolumite, the rock in which the diamond has been found embedded in Brazil, is a massive quartz, rendered in the same way flexible. The microscopic "ball and socket joints," of which an American professor has declared it is made up, existing only in some strange fancy. What these are to the otherwise rigid sandstone or quartz rock, the minute scales of graphite are to the cast iron upon which they confer flexibility. And we may find the same analogy much nearer home; the simple reason why dark gray pig iron breaks with greater difficulty than white cast iron of equal or even greater co-efficient of ultimate resistance to rupture, is, that the former is tough, that is, it *bends* more or less before it breaks; the latter is rigid and breaks short. What confers the toughness and bending upon the former is the interdiffusion of scales of graphite in all directions; and we may add, that these scales, being broad and large, are the cause, or one of them, of the weakness of many descriptions of dark gray pig iron, such as much of that of Scottish make.

Lastly, a difficulty may have occurred to some as to our views, of this form:—If it be the fact that no decarburization of the castings takes place in malleableization, how is it that the hæmatite powder in which they are heated is more or less deoxidated, the powder being contained in a cast-iron close cementing pot? Those who are acquainted with the facts elicited by Dr. Graham as to the inconceivable facility with which hydrogen passes through cast iron, like water through a filtering stone, will see that there is in this alone sufficient means for even the complete reduction of the hæmatite, were the temperature high enough and the action long enough continued, and that even were the cementing pots really hermetically closed vessels of cast iron.

Returning now to the physical properties of malleable cast iron, after the annealing process has been completed in the best manner· the specific gravity of the material is about the same as cast iron, say MM. Pelouse and Fremy (*Traité de Chimie*, t. iii., p. 291). Its density is far from being equal to that of wrought iron, says M. Brüll: that of three pieces taken at random gave 7·10, 7·25, 7·35 specific gravities. Now, as the average specific gravity of wrought iron may be taken at about 7 69, and frequently rises to 7·80, there is here a strong indication that "malleable cast" is not merely wrought iron procured in a roundabout way.

The fracture of malleable cast iron is very variable, but as far as our own observations have gone, very generally duller and less lustrous than that of any wrought iron; and we have never seen any appearance of fibre, such as characterizes tough and flexible wrought iron. The fracture is very commonly an earthy one, like that of dull common pottery, though different in colour and lustre; but from the flexibility of the material, which often requires a good deal of bending and hammering before it is broken, the character of the fracture is apt to get very much masked by partial mechanical condensation of some of the parts.

In a word, the fracture, when made with due precaution, is, on the whole, that of excessively fine-grained and very white *cast iron*, not of wrought iron. But there are minute differences of characteristic, hard to describe without many words, which may enable an educated eye usually to decide between the finest-grained cast iron and malleable castings. In large pieces the fracture is never quite alike all through. When filed or cut in the lathe or planing machine, the surface, though often rather whiter to the eye of the writer than that of wrought iron, possesses much the same characters.

It is stated by several authors to polish *better* than wrought iron, and as well as cast steel, under the action of emery and rouge. There is no doubt but that the lustre and polish thus procured are better than on *many* sorts of impure and dark-coloured wrought iron, often containing minute streaks of cinder, &c.; but so far as our observation goes, the polish is much below that of fine steel, as in a first-class razor blade, &c., though the light reflected seems rather whiter. As good a polish, we believe, can be procured upon the surface of thoroughly chilled cast iron by equal care in manipulation.

As regards hardness, we are not aware that any experiments giving numerical comparisons have been made. Generally speaking, malleable castings are very soft; much softer than almost any wrought iron of commerce, even the charcoal iron of the south of Europe. Its surface *dints* under the peign of the hammer with a very slight stroke, and it is abraded rapidly by friction against hard and rough solids. This may be seen by the rapidity with which the bearing points of malleable cast saddlery mounting, the edges and surfaces of garden hoes and like implements, and the bits of keys of door-locks, wear away in use. Though greatly closer-grained, it appears to be no harder than most soft gray cast iron. As might be expected, from its low specific gravity, it is extremely porous, and in many specimens of large size, both the pores, which are quite irregular in form and empty, as well as the minute crystals of diffused graphite, may be seen, in fragments under a high power with the microscope.

It is stated by Brüll that oil cannot be contained in a pot of malleable cast iron, but comes sweating through it after some days. We confess we entertain considerable doubt as to the generality, at least, of this as a fact. It seems very much a statement of the like kind with that which has been so repeatedly made as to liquids being forced through the pores of the cast iron of hydraulic press cylinders, which, we believe, has never been proved to have occurred, unless the casting had defects of continuity somewhere. In the lathe malleable cast iron works smoothly and well. Northcott, in his recent treatise upon Lathe Turning, says (p. 70) that it works about as easily as wrought iron, the tool being perhaps rather sooner blunted. When in *large* pieces, however, it is seldom that malleable castings turn well, if they have to be cut into at all, or anywhere deeply. This arises from unequal malleableization; when the tool gets into the core it is, in fact, acting upon "chilled iron," and the speed at which the one portion turns well, will not answer for the other.

Clock or other like bells, when cast from Cumberland pig iron, and in the chilled state, are far more perfectly elastic than after they have been annealed. If we strike a bell of the same size, in each of the two states, the note from the unannealed one proves *higher* and clearer than that of the malleable one. There is thus a lower elastic modulus for the same white cast iron when hard and after annealing. The co-efficient of elasticity also varies with the thickness of the piece that has been annealed: for, according to the experiments of General Morin and M. Tresca, it is nearly 19,000,000 for bars of only 1 centimetre in thickness, and little more than 16,000,000 for bars of 3 centimetres thickness, while it is no more than 14,750,000 for the central core of a bar of 4 centimetres thickness. The average co-efficient is thus below that of many good makes of wrought iron, though equal to that of some to be found.

As respects toughness and flexibility, thin pieces, not exceeding one-fourth or three-eighths of an inch, can be bent when double cold with ease and without cracking; few specimens, if any, will bear bending back again without fracture, partial or complete. Small rods, as large perhaps as "nail rod," can be hammered cold, and even "drawn out" a good deal under the hammer without cracking, perhaps as much so as rather inferior bar iron.

We have found that it will not bear the crucial test of the blacksmith however; the point of a rod cannot be hammered with strong and quick blows until it grows *red-hot* without dropping off or into fragments. In thin surfaces or sheets it admits of being struck in a die, so as to change its contour, provided the degree of hollowness or roundness to be given be not very great. It will even bear cold rolling to a moderate extent. All these operations, hammering, stamping, rolling cold, close up the grain of the metal more or less, and its fracture subsequently more nearly approaches that of fine-grained "steely iron." We have no facts as to how far malleable cast iron admits of being passed through the draw-plate; but we may assume it capable of a feeble extension, and of a closer grain thus conferred.

At a moderate red heat, rather above cherry red, it forges under the hand hammer tolerably well, but within narrow limits of change of form. If attempted to be largely "drawn out," it begins to crack and falls to pieces. So far as the writer's observation goes the above temperature, and certainly below a clear yellow heat, is that at which it forges best; but it is more than probable that different specimens from different makes of pig iron may require some variation in this respect. It is a branch of the subject worthy of further investigation, because many objects that hitherto have not been fabricated from malleable castings might be made from it with advantage and economy, if the forms given in the casting admitted of subsequent change of form in dies or otherwise at a high temperature. At a yellow heat malleable castings drop in pieces under the hammer, and if a large and unequally annealed bar be thus treated the unaltered *core* is sometimes found in a state of fusion, or of viscidity at least.

From this it may be seen that in reality malleable castings cannot be really welded, *i.e.*, welded under the hammer or under pressure dies. Two pieces may be made to *adhere*, at the temperature approaching fusion, if means be taken to prevent or to remove the oxide at the surfaces of contact; but this is not welding, but only "burning together"—a process which is not confined to the plumber nor to easily fusible metals, but, as we shall show hereafter, may be practised on a large scale with ordinary castings in iron. Of course, as it will not weld to itself, it cannot either be welded to wrought iron or to steel. It admits of being solidly united, however, with either of these last materials by "brazing" with "hard solder." No experiments have been made upon the co-efficients of conductivity for heat, or for electricity of this material. We may analogically predict that these will be less than for wrought iron or steel, but possibly greater than for ordinary cast iron. If so, the fact would suggest some new and useful applications of this material. Nor has the co-efficient of expansion by increase of temperature been determined, that we are aware of. This also is worthy of being fixed, for many uses for malleable cast iron can be imagined in which this would prove an element—as for parts of measures or measuring instruments.

The fusing point of malleable castings is high, a good deal above that of gray or mottled cast-iron, but, so far as the writer's observation without pyrometric aid goes, not higher than that of a great deal of white or chilled cast iron, or of most "finery pig." It is certainly far below the temperature at which cast steel becomes liquid, or that at which wrought-iron nails fuse. Malleable cast iron is stated to oxidize more slowly, when exposed to the scorifying action of a naked fire, than cast iron. In France, we believe, melting pots for silversmiths have been a good deal made of it. Whether it alloys with the silver more or less than cast iron we have no information. Lord Rosse found that speculum metal (copper and tin) could not be melted in wrought-iron crucibles without pretty rapid contamination with iron, but that cast-iron crucibles appeared without action on that alloy. M. Brüll states that malleable cast iron admits of "case hardening," either when surrounded with the usual "case-hardening" powders, *giving carbon*, or when rubbed into ferrocyanide of potassium, as practised for wrought iron.

It certainly is more or less hardened when quenched at a bright red heat in water, but the hardening is imperfect, unequal, variable, and altogether different from that of tolerable steel. In fact, it appears to harden no more than does iron in any one of its various forms or conditions when suddenly cooled. Upon this point also, however, more precise experiments are wanted. Perfect hardening in water is almost the only real test that marks a distinction between steel and iron in all other states. Certain and peculiar alterations in volume, and different in different directions, have been noticed in cast steel suddenly hardened to the utmost; it might throw additional light upon this unquestionably curious form of iron were like determinations made for it.

The experiments of Morin and Tresca prove that the elastic limit of malleable cast iron is low, a good deal below that of even rather inferior wrought iron. This limit is passed before the total range of extension or of compression is more than about half passed through. It is thus beyond question not a material to bear severe strains; and even for such purposes as saddlery and horse gear—in stirrup irons, bits, &c.—ought not to enjoy, for either cavalry or hunting purposes, a confidence equal to that for the like articles forged in good tough steel. M. Tresca has concluded that stirrup irons for cavalry are better in this material than in *forged iron:* that may be so, but they certainly are not so good though much cheaper than those of suitable steel. The co-efficient of rupture by extension is, according to Morin and Tresca, 35 kilos. per square millimetre. But it has to be borne in mind that, as this co-efficient varies with the transverse section of each individual specimen, and is less in some proportion as the section is greater, so it cannot be in all cases and implicitly relied upon. Where the co-efficient of rupture was in the unannealed cast iron 14 kilos., that of the malleableized castings was found to be from 26 to 36 kilos. per square millimetre in round numbers, and the final extension at rupture from $\frac{10}{1000}$ to $\frac{12}{1000}$ of the unit length. For those who desire to examine in full the numerical results of the experiments made by General Morin and M. Tresca they may be found in the *Annales du Conservatoire*, and a resumé of them in M. Brüll's paper read to the Society of Civil Engineers of France in 1862–63.

As quite a special branch of ironfounding, and as one having many points still pursued by the rule of thumb or precedent, and whose principles are yet ill understood, it appears worthy of the extension we have here given to its treatment—which is now concluded.—Ed.

HYDRAULIC BUFFERS.

The short discussion which we gave at pages 268–69–70 of the present volume of this journal, has called forth a *seriatim* reply from Colonel Clerk, which we add below. We are generally ready to open our pages to a full and legitimate discussion of any objections which, on a *prima facie* view of a proposal, we find it necessary to state, in order that the views which we had propounded may be either verified or, if possible, shown to be in error. We cannot, however, admit that Colonel Clerk has as yet swept away the practical difficulties which do, in an apparently insuperable degree, hang around his proposal. By all means should the suggestion be fully considered by competent railway engineers.

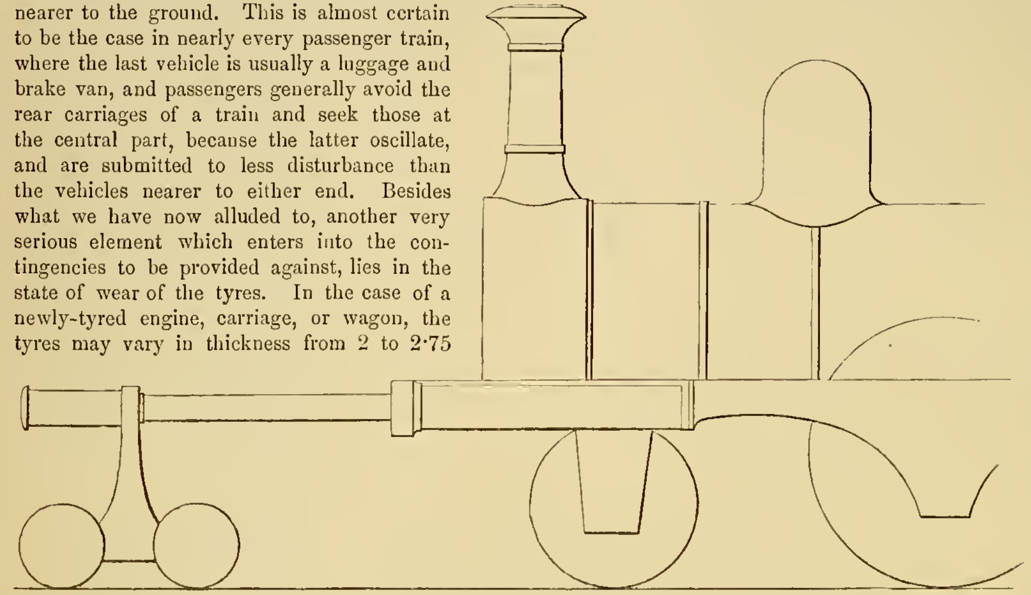
We insert here Colonel Clerk's remarks, and refer to them below:—

Remarks on certain objections to the application of Hydraulic Buffers to Railways, made in the Practical Mechanic's Journal *of 1st December*, 1868.

OBJECTIONS.	REMARKS.
1. With existing rolling stock it is rare to find the buffers of the engine and carriages in direct line with each other, &c., &c.	1. As no engines or carriages are at present fitted with hydraulic buffers, they would, if ever tried, have to be attached for the first time; and there would be no more difficulty in determining a uniform height from rail, and uniform distance apart from centre to centre of piston rod, than there is in having a uniform gauge for the railway.
2. That the long six-feet rods, without continuous support, would soon work loose in their bearings.	2. In the printed paper no details were shown, as it merely had reference to a general principle; but it was never contemplated that the piston rods were to be left unsupported. There are several ways of supporting them: for instance, the ends might be attached to a small trolley, and be connected together by a cross bar, so as to form a front carriage, which would be shut up on impact like a telescope, according to the annexed diagram; or the ends of the rods might project through the ends of the cylinder, and be counterbalanced or supported by a movable bar underneath; but, probably, the trolley would be found most suitable. Again, in order to withstand the impact, the rods should be of great strength; they should, therefore, be hollow cylinders, of nearly equal diameter to that of the external cylinders, and if supported by a trolley, need not be limited to a length of six feet.
3. If the collision took place on a perfectly straight bit of road, the shock might perhaps be straightly and effectively met, but if on a curve, they would meet at an angle, and would almost certainly be deflected from each other, &c.	3. It appears by the Board of Trade regulations that the shortest radius of curvature round which a train should travel at full speed is half a mile. With this radius the angle would be only $1'\,1\frac{1}{4}''$, and the distance between the outside piston rods, when those inside were in contact, would be only 0·26 inch, a difference hardly appreciable; and the ends of the rods being connected together by a cross bar, there would be little tendency for them to deflect. Besides which, the globular ends of the rods represent thick pads of leather, cork, or some soft substance, to take the first blow, and in some measure compensate for the slight inequality of the blow in the case of meeting on a curve.

There are no doubt many difficulties to be overcome, and the object of my paper was to draw attention to the subject, in order that some preliminary trials should be made. The principal point to be ascertained is the highest velocity at which the water can be driven through small holes so instantaneously as to act as a perfect buffer; *i.e.*, that the moving body should be brought to rest quite gradually, not suddenly. It may be found that it is not possible to bring an engine entirely to rest in six feet, but merely to reduce its speed from thirty miles an hour to about ten, or such a speed as would not cause destructive effects on impact; and the force remaining, after the hydraulic buffer has done its work, could be taken up by the ordinary buffers now in use. I am at present commencing a series of experiments to elucidate this point.

1*st*, To these remarks we reply, that although the said "hydraulic buffers" would, of necessity, have to be applied for the first time, and that there would certainly not be much difficulty, in the case of new rolling stock, to place them on engines, carriages, and wagons, with their centre lines coinciding; yet, with existing rolling stock, having the height of the frames from the rails varying as much as a foot—and it is to the frames, as the strongest and stiffest parts, that these cylinders must, if ever, be attached—there would be a very serious difficulty in getting these centres in all railway vehicles to coincide; just, in fact, as at present exists with the short stumpy buffers in use. A still greater difficulty presents itself: for although the centres of all the buffers in the kingdom might, by the use of a uniform standard gauge, be made coincident prior to leaving the erecting shops, yet how are they to be maintained so? A very common case is to find in a train, an empty, or very nearly empty, carriage next to a very heavily laden one; the result of which is that the buffers of the empty vehicle are at the highest distance off the ground, whilst the springs of the laden vehicle are so much compressed that the buffers are brought much nearer to the ground. This is almost certain to be the case in nearly every passenger train, where the last vehicle is usually a luggage and brake van, and passengers generally avoid the rear carriages of a train and seek those at the central part, because the latter oscillate, and are submitted to less disturbance than the vehicles nearer to either end. Besides what we have now alluded to, another very serious element which enters into the contingencies to be provided against, lies in the state of wear of the tyres. In the case of a newly-tyred engine, carriage, or wagon, the tyres may vary in thickness from 2 to 2·75 inches; whilst these, when worn, may not be more, and sometimes even less, than an inch thick. This circumstance will also introduce innumerable variations in the height of the buffers off the rails.



2nd, That although in the original printed paper no method was shown of supporting the long buffers, yet the proposal now made of carrying their outer ends on a trolley, according to the diagram, is still impracticable; because one of the most desirable attainments in all future railway engineering is to provide engines with the shortest wheel bases, in order that still sharper curves may be traversed both in vale and mountain than what are yet adopted. Now, according to this sketch the wheel base of any engine to which it may be applied would, by the introduction of the trolley, be rendered many feet longer than it was before. It may, however, be suggested, that this objection is to be overcome by using a bogie trolley; and whilst this may in some degree mitigate the former objection, still, we should imagine that so light an appendage as the proposed supporting trolley would be, would rattle about on the rails at a high speed of engine to such a degree, that not only would the wear of the buffer rods in the cylinder be nearly as great as without such support, but that any of those shocks which engines and trains have to withstand through inequalities in the road, and a host of other causes, would jerk so light a rolling weight off the rails, thereby bringing inevitable damage to engine, and, in all probability, throwing both it and the whole train off the road.

3rd, We certainly admit, that judging from the original diagram which we reproduced, that we considered the ends of the buffers were to be round solid masses of the same material as the buffer rods.

In conclusion, we must repeat that the case of a train collision is so entirely different from that of checking a heavy gun's recoil, that equally different means must be adopted to meet each set of circumstances; and whilst we do feel readily assured of the great success which attends the hydraulic buffer firmly fixed into the gun slide, and all the parts of which are steadily at rest previous to the instant of recoil, yet we do equally consider that the application would not only be useless, but fraught with an excessive degree of danger, under the circumstances of high rates of speed and decidedly unsteady movements of two trains on a line of railway.—V. D.

ANCIENT COINS AND METHODS OF COINING.

By Joseph Newton, Royal Mint.

(Concluded from page 267, vol. 4th, third series.)

The hammer and die system of coining existed for a very long period, and the coins which resulted from it present a sharpness of outline which is not present even in the most skilfully produced cast money. In the small museum of the mint there are to be seen several specimens of primitive implements used in the manufacture of coin, as well as dies of almost every subsequent epoch in the annals of the English coinage. Collars of lead, which have evidently seen some service, are to be found at the same place, and these were clearly used to deaden the jarring, which otherwise would have inconvenienced the workman who held the die at the moment the hammer struck it, and thus impressed the coin. The museum attached to the imperial mint of France is of a very superior kind. In it are to be found well-made models of all the machines which at various periods have been in use in that country for the production of money, together with an admirable and very large collection of medals, coins, and dies of each reign. In this respect at least the Paris mint has the advantage over that of London.

It is believed that it was in the time of Athelstan when the practice commenced in Britain of casting globules of metal for conversion into coin. These resembled bullets, and were placed upon blocks of stone to receive their impressions from the stamp and hammer. The blows administered at once flattened the globules, and left the rude devices on their surfaces. Although the use of iron or steel dies, incident to this method of coining, occasioned the employment of a smith and an engraver, yet the personal staff of each provincial mint remained very small, and, in fact, scarcely exceeded that which had existed when the pot and mould plan prevailed.

It is unfortunate that the name of the individual who suggested and carried into effect the next notable system of money-making is unknown, as he deserves credit for his ingenuity. Cylindrical ingots, or bars rather, were now cast of considerable length, and of the precise diameter of the various denominations of coin to be produced. These, when cut into discs by such rude tools as were available, yielded blanks of nearly the requisite thickness and weight. By the application of the file, and the use of a pair of scales, the blanks were "sized" or adjusted to the legal standard. When this was accomplished nothing remained but to deposit the pieces of metal one by one upon a die, and then administer to another die, carefully held upon the embryo coin, a sharp blow with a hammer. This arrangement still obtains in some of the mints of the native and independent princes of Hindostan, and it certainly has claims to some consideration nearer home. It would seem by no means an irrational idea to cast cylindrical bars for the purpose of making circular coins; and in these days of mechanical triumph, the moulds might be so formed as to insure the production of very perfect castings. Or the metal might be forced, as in the case of lead used for making Minié rifle bullets, through steel dies of the exact diameters of the several coins of the British series. In this latter case the metal would gain in density by the pressure applied to it when in a semifluid state, and hence be better adapted to coining purposes. The resulting rods or bars, after being sheared to handy lengths, could be sliced by self-feeding machines into discs, which would need no filing to size them to standard weight. Such a change of system would tend to minimise the mechanical appliances of the mint, to reduce the cost of coining very much, and at the same time would be in accordance with mechanical propriety. Whether practical difficulties would present themselves in the realization of the scheme on a large scale is another question, and one which nothing short of experiment and experience will solve. As it is, rectangular bars of metal are cast in almost all mints of any magnitude, as well as in that of Great Britain, for the making of coins, and they have to undergo many manipulatory processes before the desired end is obtained.

By the rectangular method very little more than half the metal originally put into work is stamped at the presses, until the melting pot has been put a second time into requisition. In fact, it is considered very good coining indeed if seven-twelfths of the weight of a batch of rectangular bars is obtained in the shape of coins. The remaining five-twelfths consists of what engineers would call "scrap," but which, in the technology of minting, is known as "scissel," and which has to be recast into bars for future manipulation. The *cost* involved in such repetitions of melting, and operations subsequent to it, will be readily understood, and need not be further adverted to.* By the cylindrical rod method, if it proved successful, at least ten-twelfths of the metal put into work would be convertible into coin, without having recourse again to the crucible.

This, however, is a digression, but perhaps it will be pardoned. Reverting to ancient times and ancient authorities, it may be stated that the Red Book of the Exchequer (*temp.* Edward I.) describes the manner rather explicitly in which the "new money" was coined in the eighteenth year of the reign of that monarch:—First, the metal was cast from the melting pot into long rectangular bars; these bars were cut by means of shears into square pieces; then with hammer and tongs they were forged into circular form and sized; after this they were "blanched" or made soft by annealing, and cleansed by being put into boiling acid. Afterwards, the blanks were placed between dies and struck, as previously described. The advantage of these laborious and tedious proceedings is not very apparent, but they continued in force until about the year 1561. Queen Mary had, however, previous to that date—namely, in 1546—consolidated the royal mints of the kingdom within the Tower of London, and, as a matter of course, abolished or closed all the provincial mints.

The year 1561 is rendered remarkable in the annals of British minting by the introduction of a great improvement in the art of money-making. A Frenchman was its author, and it was known as the "mill and screw" process. It was successfully put in practice within the Tower mint—the site of which is in the north-east corner of the venerable fortress and now known as Mint Street—and for very many years afterwards continued in force. The inventor came, nevertheless, to a sad end. After instructing the moneyers of the royal establishment in the use of his new coining appliances, his services were dispensed with, and he opened an opposition mint on a small scale: in short, he commenced making coins for his own use at his own house. Detection of the fraud speedily took place, and in accordance with the sanguinary laws of the period, the luckless Frenchman was condemned to death, and executed at Tyburn.† Fortunately for his memory, his name is not remembered. In 1629 a royal warrant was issued authorizing one Nicholas Briot, the then noted engraver to the mint, to make trial in the Tower of his new method of coining money by "mills and presses." What that method consisted of exactly is not known, for through the opposition of some of the officers of the establishment, Briot was never allowed a trial. In 1649 the "Council of State and Commons in Parliament," having had it represented to them that the coins of the government might be more perfectly and beautifully done, ordained that one Peter Blondeau, of Paris, should be sent for, he having distinguished himself in that direction in France. Blondeau accordingly came to London, but vested interests or jealousy on the part of the moneyers prevented his developing his plans at that time, and he returned to Paris. It was not till 1662 that Blondeau, again sent for, was in a position to overcome the hostility of his antagonists, and the moneyers—who farmed the mint, so to speak—agreed that he should "furnish all the mills, rollers, presses, &c., necessary for the completion of his plans." This description of appliances gives a good idea of their character, and demonstrates the fact that they were prototypes—rude enough by comparison, no doubt—of the rolling mills and stamping presses now employed on Tower Hill.

By their agreement the moneyers were bound to pass the plates of gold or silver through the *horse* mill, and to cut, flatten, size, "neale," blanch, and coin the pieces; to *maintain the horses;* to find alum, argot, and sawdust; to keep in repair the ovens, furnaces, and utensils for nealing and blanching; to make good the balances, small files, tubs, trays, bowls, and sacks, and all waste of gold and silver in nealing, blanching, and working.

With modifications contingent upon the improvements generally in mechanism outside the walls of the Tower, Blondeau's system of coining prevailed till the year 1810, when the old fortress ceased to be occupied for minting purposes. The institution of moneyers, which had existed in some form or another in this country from the days of the Saxon heptarchy, was abolished, after the hostile report of a Royal Commission in the year 1851, and since that time the mint has been managed directly by government officials.

Full particulars of the manner in which money is now manufactured at Tower Hill have been already furnished in the pages of the *Practical Mechanic's Journal*, and it is needless to recur further to the inner life of that place at present. In another chapter or two we shall inquire into the various methods of producing base money which have been practised in past times, and explain the nefarious systems now in use for imitating coins of the realm. As it is not well to present a "bane" without its "antidote," the most practical means of detecting bad money will be also described. Reference will also be made to the extraordinary coinage of provincial tokens, which came into existence under governmental authorisation at the close of the last century, and induced much confusion and fraud.

MR. ERICSSON'S SO-CALLED SUN ENGINE.

THE following translation of a letter from the inventor to the Stockholm *Aftonbladet*, comprises nearly as much as has yet appeared anywhere in type upon the subject of this project.

For the present we give it to our readers without note or comment, hereafter we shall offer some remarks; but do not wish just yet, and until Mr. Ericsson has had more ample opportunity of publishing his notions, either to prejudice, or yet, in the least degree, to encourage the notion to the readers of the *Practical Mechanic's Journal* by any criticism upon what will find its own level after a little time shall have elapsed. The opening sentences of the subjoined letter show some confusion either of thought or in the use of terms.

"During the last few years I have spent a good deal of time in experiments calculated to ascertain whether the sun's rays can be so condensed as to become a practical means of producing a motive power. Sir John Herschel's and M. Pouillet's well-known experiments for calculating the influence of the sun's rays, however interesting, were yet of little use to me. Referring as they do to low temperatures only, they merely show what quantity of ice can be melted or of water heated within a certain number of degrees below boiling point by means of the sun's rays; whereas my inquiries were directed to the investigation of the amount of heat produced by the condensation of the rays, and their concentration on a comparatively small superficies. I have also endeavoured to discover the best means of effecting this condensation, and constructed three different machines, which I call sun machines, for the creation of my new motive power. One of these is worked by steam, which is produced by condensation of the sun's rays; the two others are set in motion by the expansive power of atmospheric air, heated by condensed rays. As my space will not permit me to describe these sun machines and the apparatus I have constructed for the condensation of the sun's rays and the generating of the requisite degree of heat, I shall confine my present remarks to the motive power itself. From my experiments I know that at the temperature required for steam-engines and caloric machines, the action of the sun on a superficies of 10 feet square, assisted by my apparatus, can evaporate 489 cubic inches of water per hour. The importance of this fact can scarcely be over-estimated. It proves the presence of an amount of heat sufficient to lift 35,000 lbs. at the rate of a foot a minute, which is rather more than 1 horse-power. (100 lbs. Swedish are equal to about 85 lbs. English.) As an indisputable proof of the capacity of the sun to produce heat, this result is, perhaps, of greater importance than any other physical truth admitting of practical demonstration. If we consider that the mean distance from the centre of the sun to the superficies of the earth is 214·44 times greater than the radius of the sun, we easily find by squaring this figure, that a single square foot of the sun's superficies must heat 45,984 square feet of our planet. In other words, given equal superficies, the sun emits 45,984 times more heat than the earth receives. Coupling this with what has gone before, we may therefore conclude that an area of ten square feet on the sun's disc is enough to work a steam-engine of 45,984 horse-power, which under ordinary circumstances would require 100,000 lbs. (Swedish) of coal per hour. This calculation, far from over-estimating the amount of heat generated by the sun, falls far below the real quantity. More than half the heat is lost during the passage of the rays through the atmosphere and the condensing apparatus. Accordingly, the actual quantity of heat generated within the confined area mentioned is equal to that which would be produced by rather more than 200,000 lbs. (Swedish) of coal. The human mind cannot conceive the intensity of a process of combustion represented by such an extraordinary consumption of coal; still less can it realize the nature and immense quantity of the burning material producing this effect. What must be the sun's fuel, when such an enormous heat is being perpetually maintained on the entire surface of a globe the diameter of which is about a hundred times larger than the earth's! What has been said will prove that, without any very extensive application of the condensing apparatus, a force sufficient for practical purposes can be obtained. Calculations which I have just completed have satisfied me that if the sun's rays, now wasting their strength on the house roofs of Philadelphia, were condensed, they might be used to set 5000 steam-engines of 20 horse-power each in motion. That the new force can be obtained without occupying ground put to other useful purposes is one of its remarkable peculiarities. To give an instance, let us suppose a Swedish square mile (equal to 49 English) covered with condensing apparatus and sun machines. Let one half the surface be occupied by buildings, roads, &c., and we have still 648,000,000 square feet free for our purpose (two feet Swedish equal to 0·593 metre). Now, as my condensing apparatus has demonstrated 100 square feet to be amply sufficient for the production of 1 horse-power, it follows that 64,800 steam-engines of 100 horse-power each can be worked with the rays thrown on a Swedish square mile. Archimedes having calculated the force of the lever, explained that he could move the earth from its position. I assert that by condensing the rays of the sun a force could be created that might arrest the earth in its course. We have scarcely begun to work the coal-fields of Europe, and already computations are being made in England when they will be exhausted. In a thousand years or so—a drop in the ocean of time—there will be no coal left in Europe unless the sun be put in requisition. True, the rays of the sun are often prevented from reaching us; but, with such a large magazine whence fuel may be obtained without labour or transport to draw upon, experienced engineers will have no difficulty in laying up a store against the rainy day. A large portion of the earth's surface is, moreover, illuminated by an ever-unclouded sun. The area over which the sun machine can work may, therefore, be regarded as equally unlimited as the amount of force that can be generated."

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* The expense to the country of each sovereign struck at Tower Hill at present has been carefully estimated, and it is just one farthing.

† The last culprit hanged in this country for false coining was Edward Lowe. On the 2nd of November, 1827, this unhappy man was drawn on a sledge to the gallows at the Old Bailey.

IMPROVEMENTS IN THE MANUFACTURE OF ENAMELLED WARE IN IRON.

Since the first introduction of this manufacture, now more than twenty years ago, and originating, if we are not in error, in Staffordshire, very considerable improvements have been made both in the quality of the glassy covering and in the thinness and evenness of its application, and the force of adherence given to it, as applied upon the metallic surface whether of cast or of wrought iron. At first the coating was very thick, not far short of an eighth of an inch, very rough, and mammellated, far from free from minute cracks, and becoming discoloured with rapidity over the fire, and quickly acted upon with acids, such as are used even in cookery. In fact, the glaze was a very fusible glass, so rich in lead and oxide of tin, and the temperature of application was so low, that adhesion was imperfect.

Some promising improvements have been comparatively recently made, but unfortunately only partially described. M. Balloubey has described (in "Wagner's Jahres-bericht," ~~1868~~) his method of enamelling cast and wrought iron. The enamelling or glazing by known methods of cast and wrought iron has been now for some time introduced, and the applied process consists in covering the previously well-cleaned surface of the metal when strongly heated with an easily fusible enamel or glass in the state of fine powder, so as to melt it upon the metallic surface, or burning-in the laid-on enamel or glass in a muffle or oven, whereby generally a better adherence is produced. A mixture of strongly basic silicates is used, so that this enamel-cover cannot be very durable, but is easily affected by acid and saline liquids. In order to protect the iron in a more durable and complete manner, M. Ballouhey proposes a process quite different from this usual one. He brings the surface of the metal, which is provided with a protecting covering, in contact with a mixture of such substances as are used for the manufacture of ordinary white glass, and then heats the whole till the temperature of vitrefaction is reached. The iron in this case oxidizes superficially. The produced oxide of iron, probably having chiefly the composition of "forge scales," combines with the silicic acid of the glass, and an iron glass subcoat of silicate of iron is obtained, which forms with the metal beneath one body. This protecting cover may be made either thin or thick; it is, however, preferable to make it only very thin, because it will then better resist inequalities of expansion without cracking or scaling off. Trials are said to have been made to glaze according to this method iron plates to be used for covering iron-built vessels, in order to protect the iron against the influence of the air and sea water, and against the attacks of marine molluscs and the growth of plants.

to b

Now, although we are disposed to believe this last method embraces a real advance in enamelling of iron, we are not so sure about the continued adhesion of the glaze; and, in any case, we pronounce the imagined application of such enamelled sheets to the sheathing of iron-built ships a perfect delusion. The ingenious thought of so modifying the nature of the glaze, that the high heat needed to flux it shall superficially cover the previously cleaned face of the iron with an excessively thin coat of black oxide before the glaze has had time to melt, and the employment of a glass of such a nature as shall seize upon the outer face of this thin *parenchyme* of oxide and convert it partially into silicate, so that, as a result, this coat shall act as a *tertium quid*, and a solder, in fact, between the metallic iron and the external glass of the glaze, is very probably found not difficult to realize. But the final success in producing a really durable enamel on a metal plate depends upon the fulfilment of one or other of two conditions: either the glaze must be more or less flexible and *extensible* in all directions, so as to give with the expansion and contraction of the metal—just as the japan coating does upon an iron tea-tray; or the glaze must have a co-efficient of expansion within the range of temperature to which the enamelled article is to be exposed, *precisely* the same as that of the metal, iron or cast iron, &c., which it covers. Precisely, we say, for the extensibility of any glass of whatsoever composition is so small, so nearly insensible in fact, that unless so, the cracking and finally parting company of the glaze from the metal surface is only a matter of a short time and the degree of change of temperature undergone.

Now, this will not be nullified by any more effectual soldering of the glaze to the face of the metal, by a thin interposed film of forge scale oxide, which *perhaps* passes insensibly, though through a very shallow range in depth of the iron, from $(FO + F_2O_3)$ on the outside to metallic iron in the interior, and from a basic glass of earthy and alkaline bases outside all, into silicate of iron and of earthy bases at the junction with the glaze. Let the glaze itself expand more or less than does the iron, and it must and will split off sooner or later. The coating of glaze, if it cannot get loose at the metallic face, will do so in some stratum above that, slitting through the silicate of iron, or the glaze itself somewhere, and in planes more or less approximating to those of the iron plate.

The first condition for success, then, in improving this manufacture, is to be found in the production of a glaze of exactly equal co-efficient of expansion with the iron; and for this end nothing would suffice, or be so rapid in yielding practical fruit, as a train of exact experiments upon the expansion of long rods of enamel of various but known composition, all being of such a nature as otherwise to permit their being fused on to iron. The material once obtained as respects this point, adhesion might be procured from glasses of probably very various composition, and from others than such basic glasses as require the production of the coat of oxide on the iron, or silicates of iron as the cementing inter-coat. But yet it seems to us that this silicate of iron coat promises well, and would be advisably kept to. The main difficulty in every case, hitherto, has been to get the glazed coating fused and spread, *without* so far oxidizing the iron, by the prolonged and high heat to which it is exposed, that when again cold the coating shall not fall off, bringing a thin scale of oxide of iron along with it.

Now it appears to us that this might be almost completely avoided, and all difficulty as to oxidation of the iron avoided, and just as much or as little oxidation as we require given to it, by burning on the glaze in one of Siemen's gas furnaces. We can there employ a pure, oxidizing, neutral, or a deoxidizing flame to heat up and nearly bring to the fusing point the material spread on the iron for the glaze; when the latter approaches incipient fusion we can use the oxidizing flame, and so just get that extremely thin film of *hammerschlag*, or black oxide (like that on the surface of the sheets of fine Russian sheet iron of commerce), which we here want. Or possibly, sheets *already* oxidated up to that point might be put at once into such a furnace, and by a pure neutral flame the glaze be burnt on, *i.e.*, fused, and caused to adhere.

Many useful applications for this ware, were it once perfect as a manufacture, might be found. For lining the interior of water pipes and cisterns it was proposed and tried in this country before 1852, but failed because the necessary conditious for durable enamel did not exist. Upon the outer surfaces of thin iron roofing tiles it might be a valuable addition, and might enable iron slating or tiling to be used in damp countries as well as at present in dry ones, and with the advantage of having brilliant and party colouration through the enamel given to the tiling. So far no real use has been made of enamelled iron ware but for culinary or like vessels, and the manufacture of these in France and Belgium, as the Exhibition at Paris of last year showed, yields a far better and handsomer product than ours in England.

Enamelled cast iron name plates, or single letters, for streets, &c., were proposed at least thirty years ago, or even earlier, and have been employed greatly in Germany and France, and to some extent in Great Britain. So far as our observation goes, they have nowhere proved permanent: frost and oxidation are rival destroying agents. Wherever such enamelled iron plates are to be seen, after some years of exposure, they are more or less defaced.

The labels of the streets of Paris, we believe, are lettered upon plates of porcelain.

The application of glass-faced plates, however, to sheathing ships is perfectly utopian. Ships' iron sheathing, like that of copper or its alloys, must not only sustain more or less fully the chemical action of the sea water and air, but the mechanical friction of the water when the ship moves, and all the violent and constant accidental abrasions to which its surface is subject in the navigating of every ship. Enamelled iron cannot do either; and as to *fouling*, the glazing itself is a first-rate *nidus* for the deposit of marine vegetable and animal organisms, quite as good, if not better, than the coat of rust which is the usual and indispensable forerunner of fouling. If iron ships are not to be sheathed with certain *suitable* copper alloys (copper alone is most unsuitable), insulated by wood from the iron body of the ship, then sheath with wood alone; but whatever *is to be* employed, enamelled iron ought not to be.—Ed.

PRESSES FOR AGRICULTURAL PURPOSES.

We are indebted for the following description of presses in the Paris Exhibition to a valuable article by M. J. Grandvoinnet, in the *Etudes sur l'Exposition.*

Screw Press with Simple Lever.—Several of these presses were exhibited, of which that of M. Guilleux, of Segré, illustrated by fig. 1, is a good example. It is composed of an oak trough or vat, strengthened at the bottom by a strong beam, through which the screw passes, the head of such screw underneath being firmly secured. The screw is carried up through the centre of an open cylindrical casing, formed in two parts secured together by pins, so that it may be readily taken to pieces. A nut is disposed on the top of the screw (as shown in figs. 2, 2*a*), which is free to turn and descend, carrying with it a beam which presses on the substance under treatment, by the intermedium of a plank and pieces of wood. If the lever be simply passed into the tube on the side of the nut, it is necessary for the operator to turn around the apparatus in order to effect the pressure, which the space at disposal for the press will not always admit of.

Fig. 1.

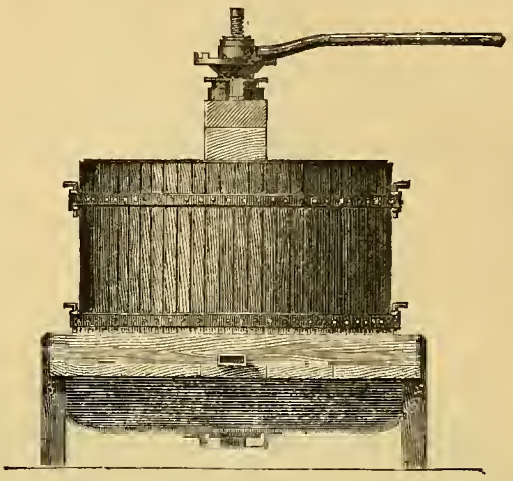


Fig. 2.

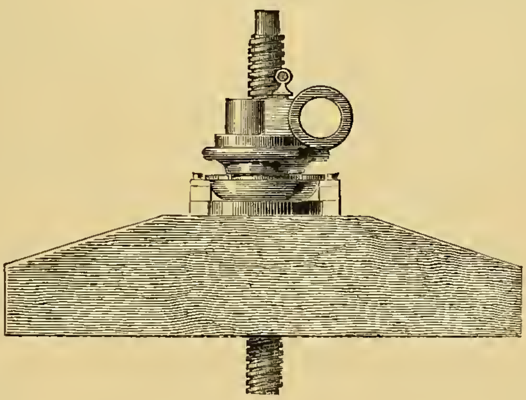


Fig. 2*a*.

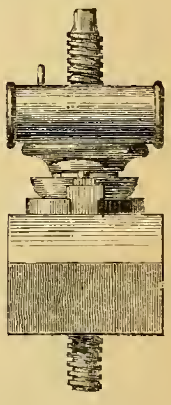


Fig. 3.

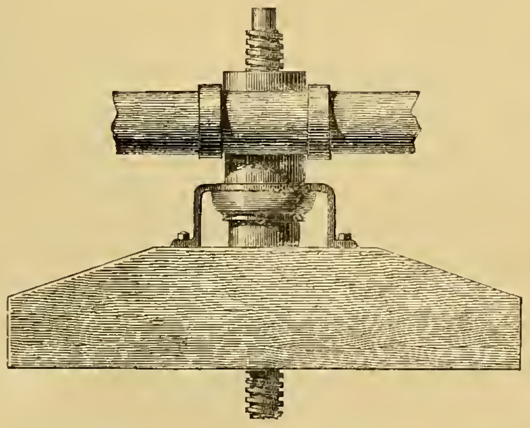
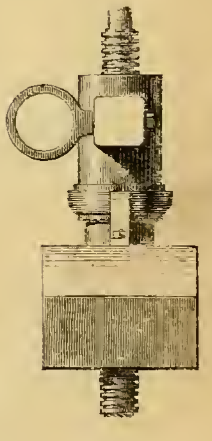


Fig. 3*a*.



Figs. 3, 3*a*, show a detail of a press of M. Guilleux, to which a species of ratchet arrangement is applied, by means of which the entire pressure may be effected without turning around the press, and thus space is considerably economized.

Juveneton's Press.—Figs. 4, 5, and 6 illustrate the press of M. Juveneton, of Tournon, on the same system as the preceding, provided with a species of ratchet arrangement to obviate the necessity for turning around the press.

In some cases it is requisite to add a winch in order to increase the power. M. Pichot exhibited a press of this description, which combined simplicity with strength, but beyond this possessed no particular feature demanding special notice. The barrel is disposed transversely, the lever being simply passed therein.

Fig. 4.

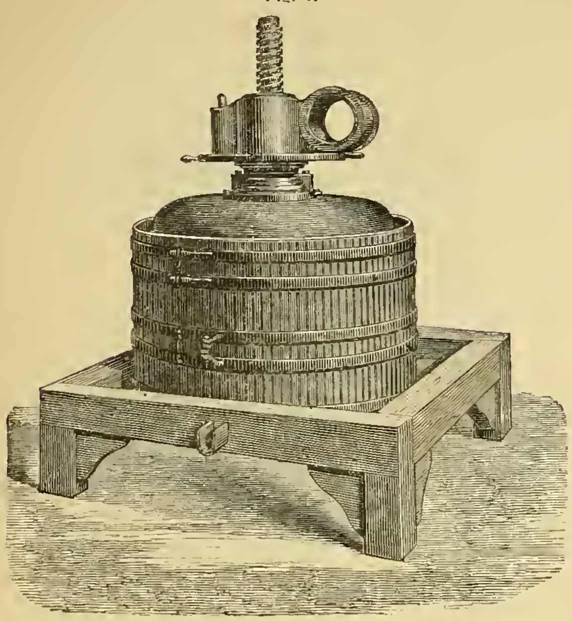
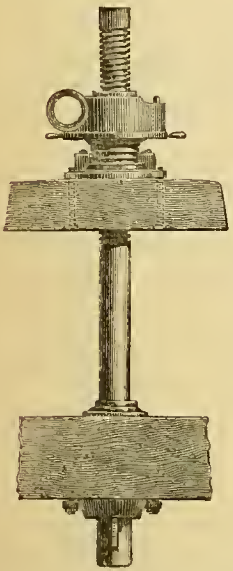


Fig. 5.



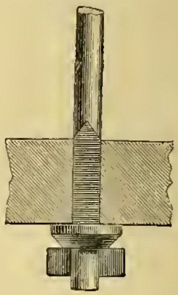
Chollet-Champion's Screw Press with Lever and Winch.—In this arrangement, which is shown in fig. 7, the barrel of the winch is disposed in a vertical plane, the frame carrying it being attached to a post or fastened against a wall. The apparatus operates in the following manner:—The cord is attached to the extremity of the lever and to the winch barrel, and the operator turns the handle until the lever completes its stroke; the pawl which is provided in the centre of the socket is then raised, and the pinion of the winch thrown out of gear, and the wooden lever is pushed back until it takes another notch or hole. During this time the cord on the barrel has been unwound, and the pawl has now only to be put in gear in order to recommence the operation.

Loquay's Screw Press.—M. Loquay exhibited only his press with three pairs of toothed wheels, but he has manufactured presses with a single pair, which are disposed in the following manner:—Two pedestals fixed in the vat support an elevated cover or cross piece, through which the screw passes; this screw terminates in a large toothed wheel, which is actuated by a pinion placed on the axis of one of the pedestals, which serves as an axle for it, and as a centre for the lever. The act of turning the lever imparts motion to the pinion which actuates the wheel, and consequently the screw; this lowers the nut which is placed at the centre of a cross-piece guided by the two pedestals. This press is certainly rather complicated, considering the object to be obtained.

The press with lever and two screws by the same maker, is, so to speak, formed of two of the preceding presses combined with a common pinion, but the arrangement is somewhat improved. The two screws are united above by a cross-piece, through which the axis of the actuating pinion passes, such axis also receiving the double driving lever. The pinion imparts motion simultaneously to two wheels of equal size, the bosses of which form the nuts of the screws, and carry with them the pressing beam in its downward motion; but in order to admit of the pressure being removed as quickly as possible, the large wheels are provided with a second row of teeth to gear with a pinion of larger diameter than that used to effect the pressing, and which may at will be thrown into action for the purpose of producing the upward motion of the beam. It is stated that with two screws the pressure is more regular and uniform, and that therefore the screws are not so liable to be twisted or broken as when but one is employed.

Presses with two or more sets of gearing.—In the majority of the presses in which two or more sets of gearing are employed, the large levers which occupy much space are replaced by handles and flywheels, and the multiplication of the power is effected by gearing acting either on the nut of the screw or on the screw itself. As these combinations are very numerous, we shall simply mention some of the more important.

Fig. 6.



Among these we may direct our readers' attention to the press of M. Marillier, of Argenteuil, in which two sets of gearing are employed. The screw passes through the bottom of the vat and is capable of turning; the threaded portion is at its upper end, and works in a nut which fits into a very strong pressing beam. Below the vat there is fitted on to the screw a toothed wheel, which is actuated by a pinion, on the shaft of which is keyed a bevel wheel which receives its motion from a pinion turned by a flywheel and handle. There were two specimens exhibited of Marillier's presses, the one on wheels, the other fixed. The upward motion is slow, there being no arrangement for changing the speed.

Coq's press, which was also exhibited at Billancourt, is constructed on the same principle, but slightly modified in detail, and is portable. The pinion in this, however, may be thrown out of gear, and the flywheel fixed on the shaft of the bevel pinion, by which the speed of the stroke may be greatly accelerated.

M. Lotte's press, also exhibited at Billancourt, is portable, and seems a very convenient arrangement. It is composed, as shown in fig. 8, of a fixed screw disposed in the centre of a cylindrical casing, and the nut of which is made in one with, or attached to, a large toothed wheel, which is actuated by two sets of gearing to multiply power. By turning the wheel, E, the pinion, G, is actuated, and imparts its motion to the wheel, F, which is fixed at the lower end of a long vertical shaft. This shaft is provided at its upper end with a long pinion, B, which transmits motion to the wheel, A, fast on the movable nut. When it is required to unscrew, the long pinion, B, is thrown out of gear by acting on the screw, C, the shaft of the pinion being jointed at its lower end. The wheel, A, is provided with handles or pegs, and may then be used as a hand-wheel to effect the rapid upward motion of the nut.

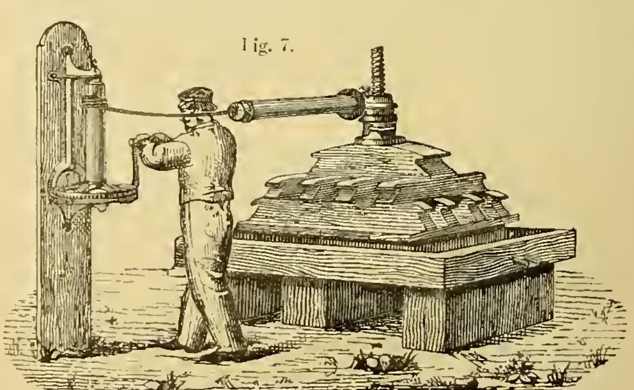


Fig. 7.

M. Loquay's press, with two screws and three sets of gearing, is represented in fig. 9. It resembles in some of its features the lever press with two screws, already described; but in this case the lever is replaced by a bevel wheel, F, and pinion, E, to increase the power. Its action will be readily understood on reference to the engraving; but the means used to obtain the pressure and the speeds appear too complicated for the purposes intended.

Lemonnier and Nouvion's press is in great reputation at Bourgogne. The model exhibited at Billancourt is illustrated by fig. 10, with the exception that a set of gearing and a handle were substituted for the click lever. All the mechanism is beneath the vat, through the body of which the screw passes. The speed for the reverse, or upscrewing operation, may be slightly increased by throwing the smaller pinion out of action and putting the larger in gear, the handle being applied at the end of its shaft.

Fig. 8.

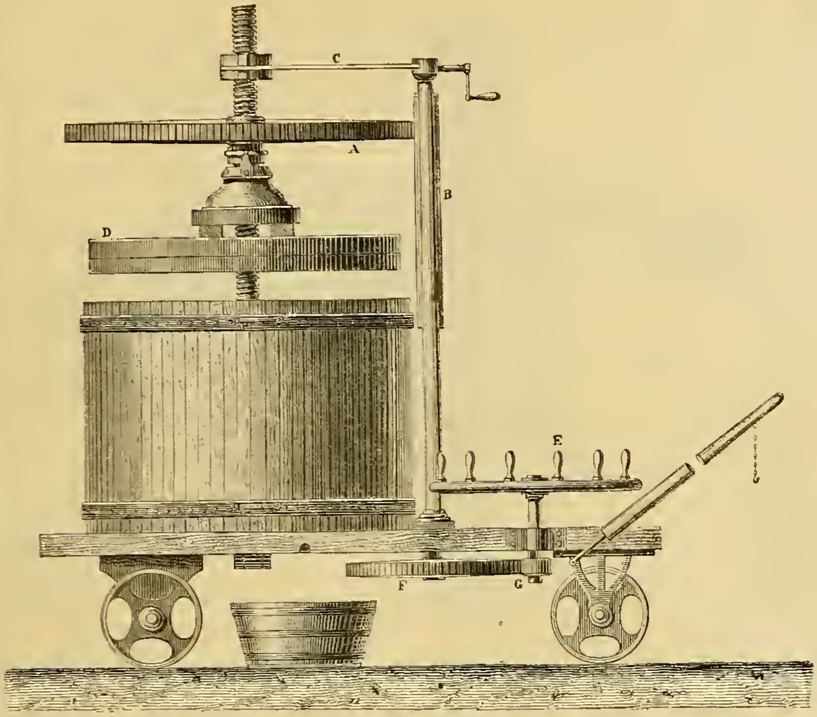
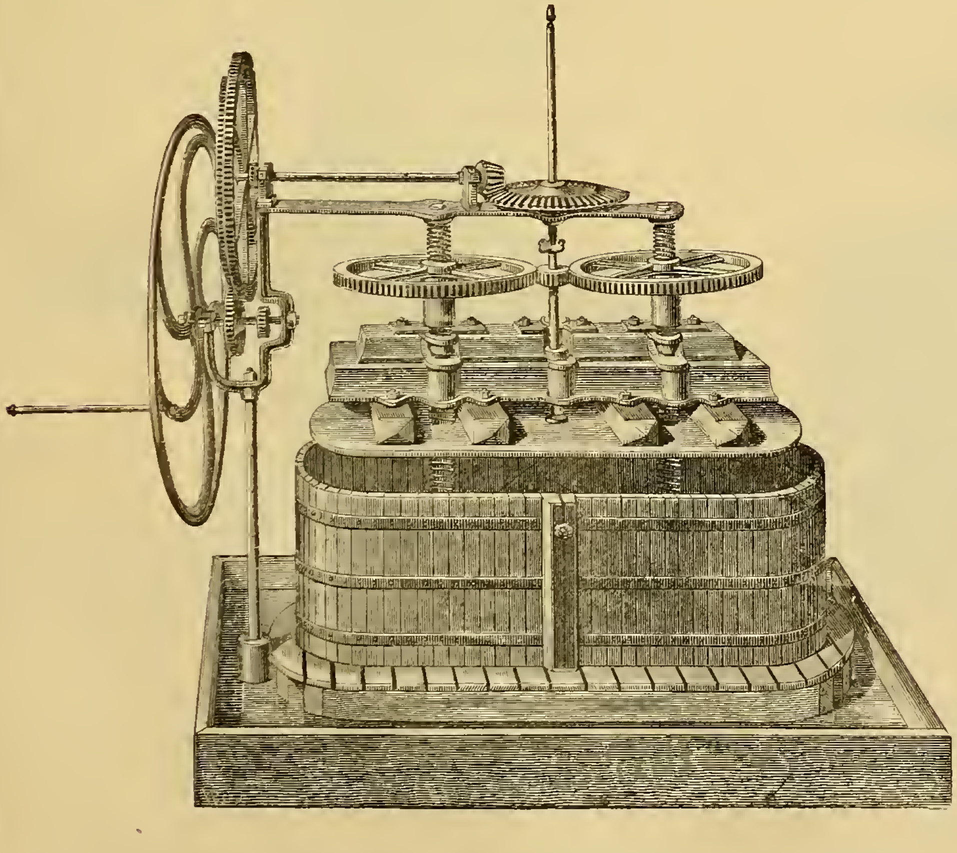


Fig. 9.



Messrs. Mabille Brothers' Presses.—Messrs. Mabille Brothers of Amboise exhibited at Billancourt two presses fitted with gearing and a lantern screw, which are worthy of observation. The more important of the two is that which they call their improved press, which is provided with self-acting means for throwing the apparatus out of gear, should the press be in danger of being broken. The multiplication of the power is obtained in the usual manner for presses of this class. The pressing is effected in three several intervals of time: viz., first, by turning the nut direct, employing as a lever the quadrangular frame which carries the gearing; secondly, by turning the horizontal hand wheel, after having thrown out of action the second wheel by removing the key which connects it with the pinion actuating a wheel placed under the nut; and finally, by replacing the key, in order that the second wheel may turn with the pinion, the operator turning the vertical hand wheel. In the latter case, all the means available for multiplying the power are in play, the nut descends slowly, but it exercises an enormous pressure. The whole of the mechanism is carried by a quadrangular frame of cast iron, which rests on the nut itself and turns with it. The apparatus for throwing out of action spontaneously, in the event of the pressure exceeding a given limit, is arranged in the following manner:—The boss of the vertical hand wheel is hollow, and is provided inside with a tongue, or projection, which, together with the boss, is pressed by a spiral spring contained in a cylindrical box which surrounds the exterior of the boss of the hand wheel, and is secured to the end of the screwed shaft by a nut. So long as the pressure is confined within a certain limit, the tongue or projection, under the action of the spring, enters a notch formed in a ring attached to the shaft of the pinion, and when the wheel is turned carries the shaft with it; but if the pressure becomes excessive, the tongue slides in its notch, since it is then capable of compressing the spring which contains it, and the boss of the hand wheel moves slightly from the washer. This distance, which is equal to the pressure to which the spring is subjected, is increased by the force, and the result is that the tongue escapes from the notch in which it was engaged, and the hand wheel becomes loose on its shaft. This arrangement precludes the possibility of the workmen out of ill-will or malice breaking the press.

The other press of M. Mabille is smaller and on a different system. It is provided with gearing and an endless screw; the pressure may be effected rapidly, since there are four speeds at disposal, and the whole is well arranged for that purpose. An upper shaft carries a pinion which actuates a toothed-wheel, the spindle of which carries another pinion which transmits motion to another wheel disposed on the extremity of a shaft, carrying at the centre thereof a three-threaded endless screw, which itself imparts its motion to a corresponding toothed wheel. All these three shafts are capable of receiving a handle at each extremity, which provides for three different speeds. In addition to this, by the aid of a small handle, the endless screw may be thrown out of action, it being removed with the whole of the frame of the wheel which actuates it. The toothed wheel, which is in one with the nut of the screw, may also be turned direct: this is, in fact, the first phase of the pressing operation. In order to continue and slightly increase the pressure, a handle is placed on the shaft of the endless screw; it is then removed to the lower outside shaft, and the pressure is still further augmented; and, finally, in order to exercise the greatest possible pressure, handles are applied to the upper shaft. This firm also exhibited models of certain other modifications.

Messrs. Chollet-Champion's Presses.—The so-called *Pressoir à boisseau* of this firm is shown in fig. 11. It is composed of one principal piece, forming at the same time, by its bottom, the socket of the nut, and a frame in the form of a collar carrying the whole of the mechanism. The socket is so strengthened by the sides of the collar in which the nut turns, that it is almost impossible for fracture to take place, which frequently occurs in other presses. The large internal toothed wheel forms, at the same time, the nut of the screw. The multiplication of the power is effected by three sets of gearing, the arrangement of which is shown in figs. 12 and 13. In order to commence the pressure, the collar or *boisseau* (shown in plan in fig. 14) is turned by hand until the resistance becomes very great, when the handle is applied to the lower shaft carrying the bevel pinion, the two right-hand pinions being out of gear. This pinion, by the intermedium of gearing, transmits motion to the internal toothed wheel which, in fact, forms the nut, as before stated. The handle is next placed on the shaft of the large right-hand pinion, and finally, to complete the pressure, on the smaller right-hand pinion, when the maximum of power is obtained.

Fig. 10.

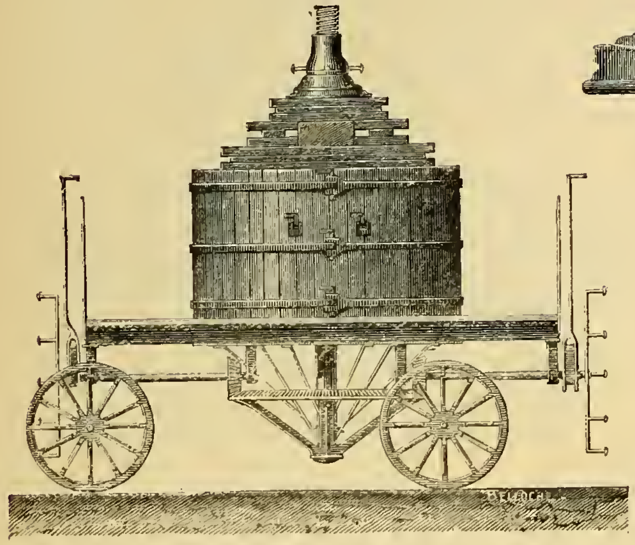


Fig. 11.

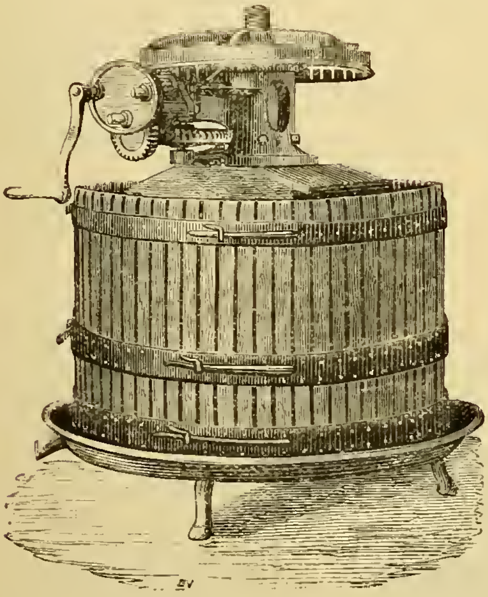
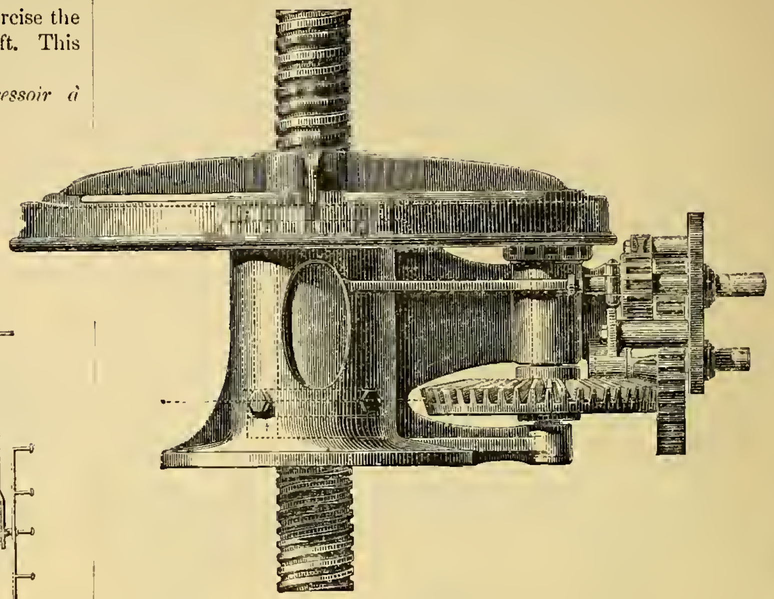
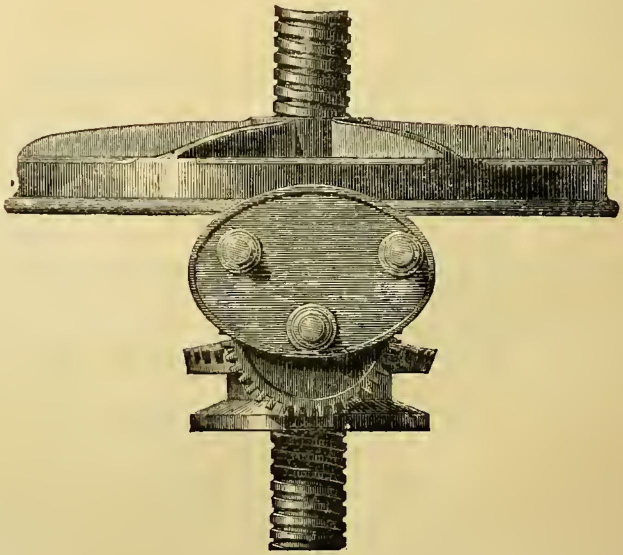


Fig. 12.



Samain's Presses.—Figs. 15 and 16 are perspective views of Samain's presses, the one of the jointed lever press, and the other of the antifrictional screw press, a description of which will be found at page 267, vol. iii. *Practical Mechanic's Journal* (third series). We insert them here simply to give a better idea of the general arrangement.

Fig. 13.



Mannequin's Hydraulic Wine Presses.—Fig. 17 represents one of these presses, in which two pistons and a central screw are employed. There is bolted to a wooden frame a cast-iron piece, A, through the centre of which the screw passes, the head being situate underneath; this cast-iron piece forms two pump barrels, provided with a packing ring, in which work two cast-iron pistons or plungers, supporting, by the intermedium of a cast-iron plate, the wooden bottom of the vat. The rising of the pistons elevates the vat; the fixed screw, which is disposed between the two barrels, passes through the bottom of the vat, and is surrounded throughout the whole height of the vintage to be pressed by a cast-iron pipe bolted to the bottom of the trough, so as to prevent the wine from running between the screw and the bottom. Water is supplied beneath the pistons through pipes, by means of a force pump, as shown. The vat is made in three parts, united together by angle irons. When the apparatus is ready for the commencement of the operation, the hand nut on the top is turned, the flat piece beneath it being attached thereto by a universal joint, so as to admit of its readily assuming any position, whilst the nut will descend vertically. This operation gives rapidly a slight pressure, and places the nut in the position of a stop. The operator then acts on the beam of the pump, which carries a counterweight to assist the up-stroke of the pump piston; the centre of rotation of this piston may be adjusted to three different positions, according to the power required, and is removed successively to each of those positions as the operation proceeds. The screw is not used to press, but to regulate the load; it is simply submitted to a tensile, and not to a torsional strain, and the ready and rapid motion of the nut admits of a certain amount of pressure being applied without its being necessary to work the pistons the whole length of stroke. In order to remove the pressure it is simply requisite to open a cock, when the water rapidly runs off, and the pistons descend by their own weight, whilst the nut is raised by turning the handle, in order to afford more space for the recharging of the apparatus.

Fig. 14.

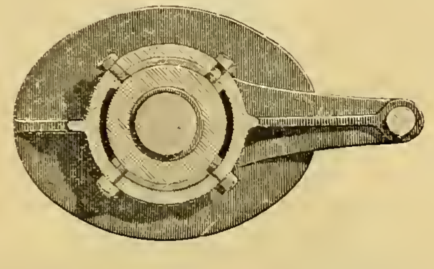
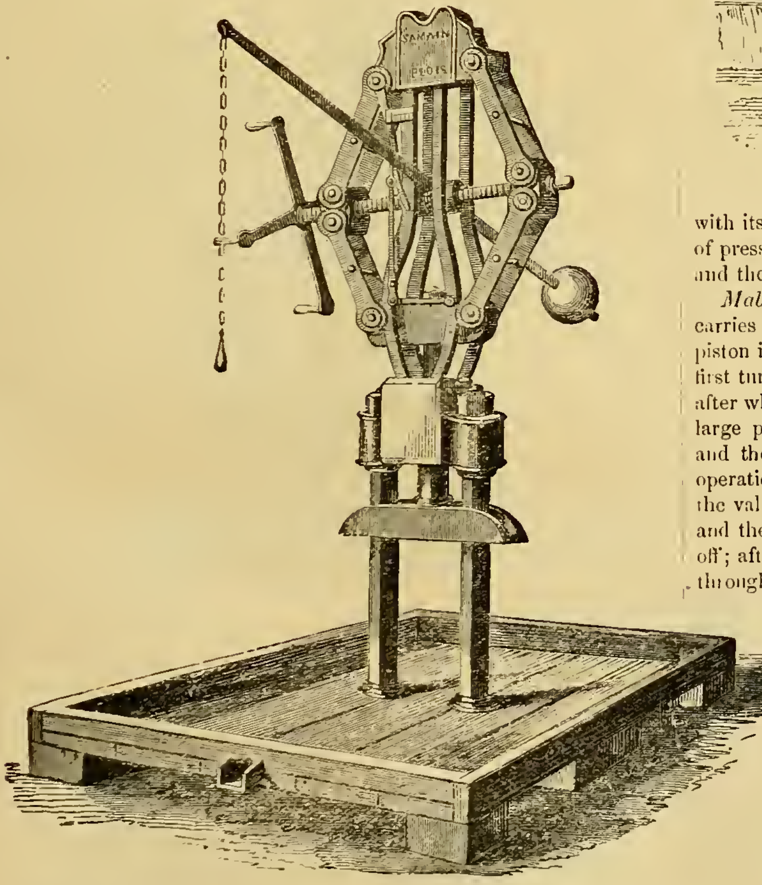
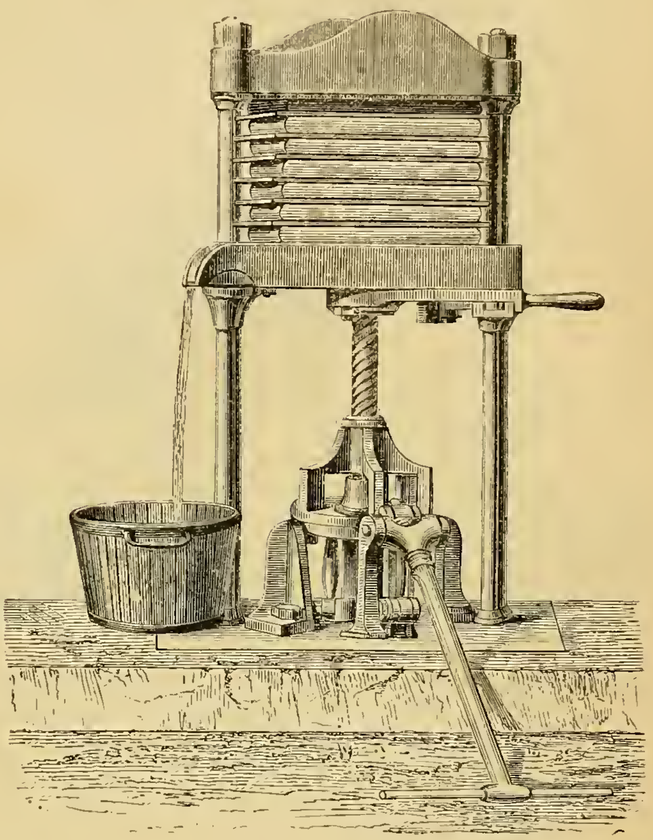


Fig. 15



The old type of Messrs. Mannequin's press had but one piston, which necessitated the use of an additional leather washer round the bottom of the screw. Fig. 18 is a general view of this arrangement. A is the barrel of the pump, B the screw, E E E the wood pressing pieces, O the trough, N the cast-iron plate upon which the piston acts, and which carries the bottom of the vat, U the lever of the force pump with its counterweight, L, and H the safety valve. After the operation of pressing is completed, the wine is withdrawn, and the cock, I, opened, and the piston descends as in the preceding case.

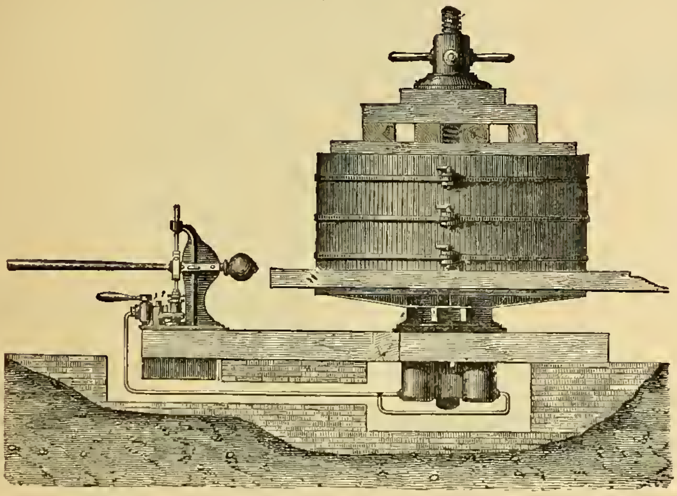
Fig. 16.



Mabille Brothers' Hydraulic Wine Press.—In this press the screw carries at its lower end a piston of large size, within which another small piston is contained. When the apparatus is ready for work, the nut is first turned by a hand wheel on the top, which commences the pressure, after which the force pump is acted on, which sends the water above the large piston, and causes the latter to descend with the screw and nut and the pressing beam which presses the contents of the vat. The operation is continued until the pressure attains its maximum, when the valve allows the water to escape. The pumping is then stopped, and the valve fixed for a few minutes to allow time for the wine to run off; after which the up-stroke of the screw is effected by forcing water through the small piston (which is made tubular) to act on the end of the cavity of the large piston in which the small piston is contained, and as the large piston rises, the water is returned to the exhaust reservoir of the pump. A pipe is provided, to expel any water which may have passed below the piston. The cast-iron plate which carries the vat is bolted to the body of the pump, and the screw is surrounded by a double tube, so as to preclude the possibility of any wine escaping. The pump is fitted with a two-way cock, so that the act of opening the inlet pipe to one piston also opens the exhaust pipe of the other piston, so that it is sufficient to turn the cock to cause the press to operate in either direction.

Chollet-Champion's Hydraulic Press.—Fig. 19 is a perspective view of this press, showing its general arrangement. In this the cover of the pump cylinder acts as a stop for the rod of the safety valve, and opens the valve, when the water previously introduced into the press cylinder escapes through an india-rubber pipe fixed on the cover. When the apparatus is full of water the plug of the pump valve chambers is successively opened and closed, in order to expel any air which may be contained therein; the pump is then ready to be put in action. There are two press cylinders, a large and small one, the latter being secured on the cover of the large. When the pump is worked, water is first forced into the smaller cylinder, which causes it to rise, carrying with it the large cylinder and its appurtenances. The cover in rising releases the rod of the valve, which then becomes closed, and cuts off the communication between the under side of the piston of the large cylinder and the india-rubber pipe before mentioned.

Fig. 17.



If the operation of pumping be continued, the water contained beneath the piston of the large cylinder will be forced through a cock, and through the feed pipe of the pump to the top of the piston; the space comprised between the top of the piston and the cover serving as a water reservoir. The apparatus may thus be raised until the bottom of the cylinder comes against the surface of the piston. In order to effect the descent of the cylinder the cock is turned to another position, when the water contained in the small cylinder, accelerated by the downward motion of the latter, passes into the feed pipe. The cock is opened gradually, in order to cause the piston slowly to descend. Since this press was exhibited a modification has been made in some of the details, the nature of which will be understood on reference to figs. 20, 21, and 22 The object of this improvement is to insure a sufficient quantity of water being contained in the press, when it is required for use. The plug, A, is almost entirely unscrewed, so as to admit of the escape of the air contained in the pump, and which would impede its working. When it is required to raise the press cylinder, the wheel, D, is unscrewed and that, C, screwed full up; the pump is then put to work, which effects the ascent of the cylinder. In order to cause it to descend the wheel, C, is slightly unscrewed, when the cylinder descends of itself on to the substances to be pressed. The operator continues to unscrew the wheel, C, and then pumps by means of the lever, G (without its lengthening piece, H), the wheel, I, being removed to the left-hand side in order to get as much stroke as possible. So soon as the resistance appears too great the lengthening piece, H, is replaced and the operation of pressing is continued, the wheel, I, being gradu-

Fig. 18.

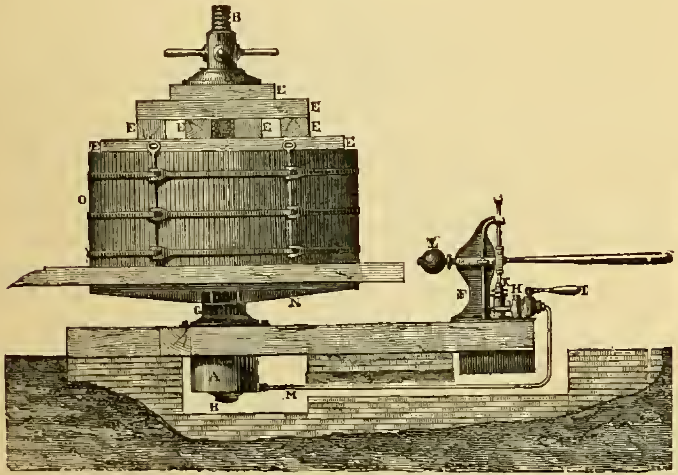


Fig. 19.

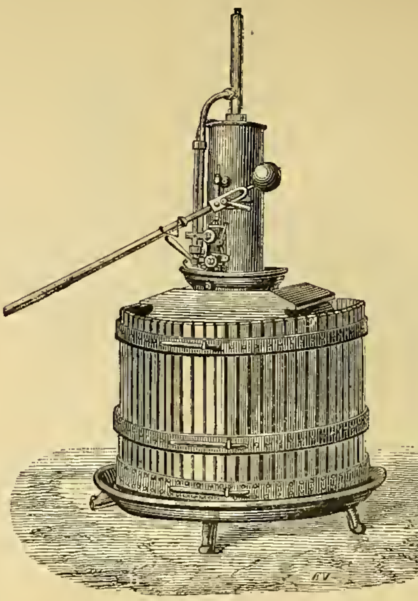


Fig. 20.

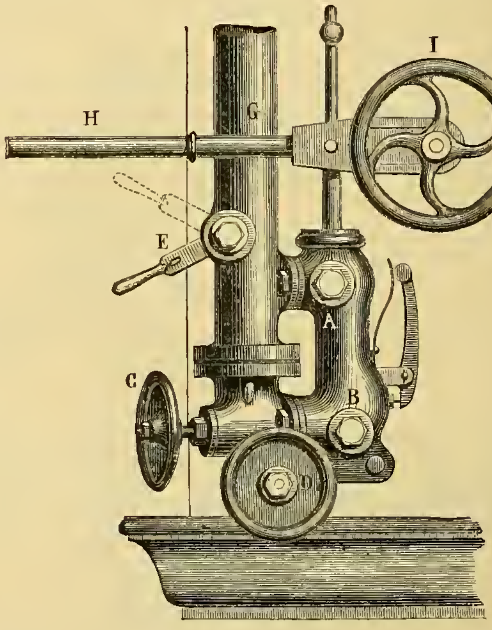


Fig. 21.

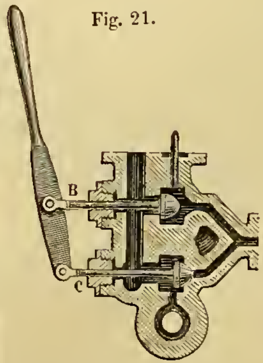
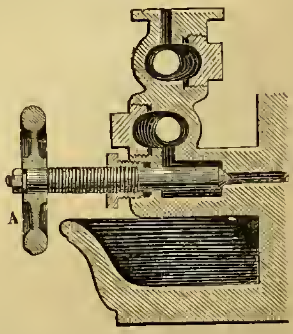


Fig. 22.



ally shifted towards the right-hand side. When the resistance attains its maximum the wheel, D, is screwed full up to prevent the escape of the contents of the vat under pressure. If the pump does not operate well, the two plugs, A and B, are unscrewed, and the valves and their seats thoroughly cleaned; after which the whole is replaced, care being taken to expel the air through the plug, A. When the parts are being cleaned the cock is in the position indicated by the dotted lines in fig. 20, so as to prevent loss of water; but it is returned to the position shown by the full lines when it is required to resume work. If after use the press has to remain in a place where it is exposed to frost, the whole of the water is withdrawn, and the parts well lubricated in order to prevent oxidation. The plug, A, serves to prevent the water losing its pressure when the operator ceases to act on the working lever.

M. Laurent, of Dijon, exhibited a fine specimen of hydraulic press, of a somewhat similar arrangement to that of the Mannequin press with a single cylinder.

Fig. 23.

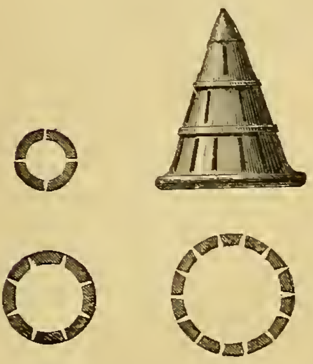


Fig. 23 represents an arrangement of cones designated "drain-cones," having apertures formed therein, and which M. de Saint Trivier proposes to place in the vat, in order to facilitate the passage of the liquid from the centre to the circumference. They are composed of cast iron and formed in two parts, which are united by rings. We think, however, it would be preferable to substitute common china for iron, and make them in one piece.

ON THE DISPOSAL OF THE SEWAGE OF GLASGOW.

From the words of the concluding paragraph of our former paper* it will be expected of us on this occasion to enter fully into the merits of Messrs. Bateman and Bazalgette's scheme. This we hope to do; but, prior to taking that step, it is necessary to lay before our readers a *resumé* of the scheme itself. This we cannot do more judiciously than by quoting from the joint report of the two engineers those parts of it which relate more especially to the disposal of the sewage, as follows:—

"We now come to the question of what the volume of the sewage is with which we have to deal, and what means or facilities exist for disposing of it or depriving it of the qualities complained of.

"The present volume of the sewage, together with other waters which must be disposed of through the sewers, may be estimated as follows:—Water supply, 27,000,000 gallons per day; water from public works which must be taken into sewers, 6,000,000 gallons per day; such portions of the Pinkston, St. Enoch's, Camlachie, and Molendinar Burns as it may be found desirable to divert, say 2,000,000 gallons per day, making a total of 35,000,000 gallons, to which must be added so much of the rainfall as cannot be excluded from the sewers.

"In the Metropolis, and in most other towns in which modern sewerage works have been constructed, the sewers have been made large enough to take ordinary rainfalls, but not what are called storm waters, and where it is necessary to resort to pumping for the purpose of raising the sewage to a sufficient elevation, either for its disposal for irrigation on land, or with the view to its being conveyed to a distance, it is of still more importance to exclude, so far as possible, all storm water, and to render the volume of sewage as limited and as nearly uniform in quantity as circumstances will permit.

"The present sewage, independently of rainfall, equals 70 gallons per head per day on the population, or 35,000,000 gallons in gross.

"Should the increase in its volume correspond to the increase of population, it would be 50,000,000 gallons per day twenty years hence, and nearly 70,000,000 forty years hence.

"This enormous quantity is largely due to the wasteful consumption of water for domestic purposes, which it will before long be absolutely necessary to limit.

"The water now supplied from Loch Katrine and Gorbals together is equal to 54 gallons per head per day for all purposes, and 45 gallons per head for waste and domestic purposes only, when the quantity supplied for trade, viz., 4,000,000 gallons per day, is deducted. The quantity for domestic purposes may no doubt be reduced, but assuming that it cannot be easily brought under 40 gallons per head, the probable result twenty years hence would be—

	Gallons per day.
Population 750,000, at 40 gallons,	30,000,000
Trade supply, through Waterworks, 50 per cent. increase,	6,000,000
Quantity pumped from Clyde for trade purposes, say	10,000,000
Burns,	2,000,000
	48,000,000

agreeing very nearly with the previous computation, notwithstanding an assumed deduction in the rate per head for domestic supply.

"The domestic supply will be given principally in the morning, and it has been ascertained from observations on the gross volume of sewage, that the flow is greatest between the hours of nine and twelve in the morning, or thereabouts, and least after midnight.

"The volume of the sewage will, therefore, vary during the day, and will be nearly twice as much at some periods as at others. The waste from the waterworks forms nearly one-half of the water nominally supplied for domestic purposes, and that will go on pretty constantly during the twenty-four hours. The water properly used for domestic purposes, and that supplied to trade, will be principally delivered in twelve or thirteen hours, and therefore at a rate double that which it would be if delivered in twenty-four. These irregularities must be considered and provided for in determining the sizes of the sewers.

"The result on the present population will be as follows:—

	Maximum Rate of Flow. Gallons in 24 hours.
Waste—Say at least 11,000,000 gallons per day, out of 23,000,000 supplied for domestic purposes,	11,000,000
Domestic supply 12,000,000 gallons per day,	24,000,000
Trade supply, from Waterworks, 4,000,000 gallons daily, " from River Clyde, 6,000,000 " 10,000,000 gallons daily,	20,000,000
Burns, or Underground Water, nearly constant,	2,000,000
	57,000,000

Upon the population twenty years hence, assumed at 750,000, the volume of sewage, worked out in the same way, would amount to a delivery at the rate of 82,000,000 gallons per day, as follows:—

	Maximum Rate of Flow. Gallons in 24 hours.
Waste out of domestic supply of 30,000,000 gallons per day, say	12,000,000
Domestic supply, 18,800,000 gallons per day,	36,000,000
Trade supply, 6,000,000 from Waterworks, " 10,000,000 from River Clyde, " 16,000,000 gallons per day,	32,000,000
Burns,	2,000,000
	82,000,000

"Much of the water supplied to public works is used for purposes which do not render it objectionable, and may therefore be discharged into the river without offence. To this extent the sewage to be dealt with and pumped would be diminished. If but one-half of the trade supply could be so treated the present maximum rate of flow of sewage would be reduced to 47,000,000 gallons per day, and in twenty years hence to 66,000,000. At all times, however, the whole of the trade supply could be taken into the sewers if desired, and it is only on account of the cost of pumping that it becomes a matter of expediency to discharge the unobjectionable portion into the river.

"To the quantity which we have now computed, must be added such an amount of rain water as cannot conveniently be prevented from entering the sewers. Much of the sewage may be intercepted at high levels and carried away by gravitation to irrigate suitable lands at distant points; but a large portion can only be removed by pumps and steam-engines, and, therefore, on the score of economy in annual working expenses, it becomes necessary as far as possible to exclude storm water. It is also desirable to have a tolerably uniform quantity of sewage to deal with, both on account of the provision which must be made for pumping it, where pumping is required, and for disposing of it to the farmer, if it is finally utilized by irrigation. We have, therefore, in considering this question, determined to reject what storm water we can, and to admit only that which cannot otherwise be disposed of; aiming at acquiring that most perfect condition of sewers in which their inclinations and sizes, and the volume of sewage flowing within them, should be such that the minimum velocity would prevent all deposit, and preserve the sewers in a perfectly clean and sweet condition.

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* *Vide Practical Mechanic's Journal*, page 264, present volume.

"With respect to the rain or storm water, which must be admitted, we may observe that excessive rains which occur occasionally cannot be carried away by any sewers of reasonable dimensions, and provision must be made for allowing their safe escape to the river.

"If allowance were made for the admission of rain at the rate of a ¼ of an inch in twenty-four hours, and coming off the area covered by streets and buildings, which is the quantity provided for in London, the volume of the sewage would be increased by about 27,000,000 gallons per day, at present, and by about 40,000,000 gallons twenty years hence. These quantities added to the maximun rate of flow of the ordinary volume of the sewage, as already computed, would give 74,000,000 gallons per day, which we must now dispose of in times of rain, and 106,000,000 gallons per day twenty years hence, excluding in each case one-half of the public works supply.

"The whole of this quantity, sewage and rain-water together, may be conveyed out of the city by intercepting sewers and by pumping from the low level; but great facility exists for discharging any superabundant water from the proposed intercepting sewers into existing sewers or channels, where they flow direct to the river, by overflows at the points of crossing. If arrangements for this purpose were adopted the quantity to be finally carried away may be reduced to the maximum volume of ordinary sewage; and, considering that whenever the overflows come into action the river itself would in all probability be in a state of flood, the small addition of diluted sewage which, at distant periods and for short intervals, must enter, would pass away unobserved and harmlessly.

"We have, therefore, after the fullest consideration, come to the conclusion, that it would be sufficient if we provide for disposing of, and for ultimately carrying off, a quantity of sewage, which at its maximum volume will flow into the sewers at the rate of about 100,000,000 or 110,000,000 gallons in twenty-four hours. This will be the volume of sewage which, at its maximum rate of flow, may be expected forty years hence. The sewers will be of great length, and must of necessity be of considerable dimensions; they will consequently possess great impounding as well as discharging capabilities. Due allowance being made for these, it will be found, as it will be hereafter shown, that the whole of this volume, together with a considerable amount of rain-water, may be received and disposed of.

"It seems to be admitted on all hands that the sewage must no longer be allowed to pollute the harbour. Most of the suggestions which have been made, however various in other respects, contemplate its removal from this portion of the river. It seems equally inexpedient, if not impossible, considering the interests at stake, to turn it into the river at any lower point, unless it be previously deprived of all objectionable qualities.

"Both banks of the Clyde are either studded with residences, or bear a succession of towns, which preclude the possibility of discharging the unpurified sewage into any portion of the river for a very considerable distance without creating a nuisance. Both banks possess great natural beauty and every inducement for the further erection of houses and places for sea-side resort. The physical features on both sides are also such that any works of conveyance would be of a difficult and expensive character; and any attempt to inclose and appropriate for purposes of irrigation the shallow sides of the estuary, would be strenuously and, we have no doubt, effectually opposed.

"We consider it, therefore, quite out of the question to propose any scheme by which the sewage shall be discharged into the Clyde at any point, unless it has previously undergone purification.

"All attempts at deodorization or precipitation on a large scale have hitherto so completely failed, either commercially or chemically, that, in our opinion, the idea of correcting the evil by any such process need not be regarded; and hence it becomes necessary, either to turn the sewage in its natural condition into the sea at some point sufficiently distant from Glasgow, and other populous places or districts, or, by allowing it to pass over a sufficient area of suitable lands to clear it of all objectional character, and to render it so pure that it may without fear of creating a nuisance be turned into the river or the sea.

"The application of sewage to land has not only resulted in an amazing increase of its productiveness, but, where the application is properly conducted and the ground suitable in character, the sewage is deprived of all objectionable smell and appearance, and may then be safely permitted to flow into such a river as the Clyde or into the sea on any part of the coast. Probably the most notable instance of the successful agricultural application of the sewage in this way, is over the Craigentinny meadows near Edinburgh, where the land has been made to produce 40, 50, and 60 tons of grass per acre, per annum, which is generally sold to persons, who cart and carry it away themselves, for prices generally exceeding £30 per acre, and in some instances upwards of £40.

"There, however, the mode of application has been defective—the ground has been-overdosed with sewage, and its objectionable qualities have not, therefore, in a sanitary point of view, been wholly removed. At Croydon, the purification of the sewage of that town, by passing over grass lands in the immediate neighbourhood, has been so successful that people residing close up to the sewage-irrigated land do not complain of any nuisance; and so entirely devoid of colour, smell, or taste is the sewage, after having passed over the ground, that on comparing a bottle of it with a bottle of water from Loch Katrine, without knowing in which bottle the respective waters were contained, one of us actually selected the Croydon Sewage Water as being that which he believed was Loch Katrine water. Similar results have attended its application at Rugby, Carlisle, Barking, and other places; and there can therefore be no doubt whatever that foul sewage, after being properly and sufficiently passed over suitable land, and applied to suitable crops, may be wholly deprived of its offensive character.

"The land which it appears is best adapted for effecting this purification, is well drained friable clay or sandy loam, free enough to absorb the sewage and gradually allow it to filter through, but not so free or open as to allow it to pass through too quickly. Sands and gravels, too, appear to produce this disinfecting result, and all crops are apparently suited for the reception of sewage, though that to which it can be most readily applied, and which, perhaps, in its turn produces the most beneficial result in its purification of the sewage, is grass land, especially rye grass, cut green and carted from the ground.

"This wonderful process of purification is accompanied by an equally wonderful increase in the fertility of the ground. Very careful experiments were made under the direction of a royal commission, some years since, at Rugby, by which the value of the increased crop was equal to 0·931*d.* per ton of sewage applied, the sewage, moreover, not having been thoroughly exhausted. At Croydon it is estimated that the gross returns from the sewage applied show it to be worth from ¾*d.* to 1*d.* per ton with Italian rye-grass, and from ½*d.* to ¾*d.* per ton with meadow grass as a crop. But the most recent experience, and perhaps the most authentic information, excepting that obtained by the royal commissioners at Rugby, have been acquired by the Metropolis Sewage and Essex Reclamation Company at their Sewage Farm, near Barking, in Essex. Mr. J. Chalmers Morton, well known as an authority in agricultural matters, had the charge of this farm, and has recently published the "Agricultural Experience of 300,000 tons of North London Sewage," which were applied on it during 1867. The gross result is that in ten months, commencing with the beginning of February and ending with the end of November, 300,000 tons of sewage, poured on 56 acres of land, produced 2500 tons of grass, or 45 tons to the acre by the application of 5400 tons, much of the ground being naturally a poor hungry gravel. Making allowance for various errors of application, Mr. Morton comes to this conclusion—"That if the whole area, 55½ acres, had yielded as much as certain plots which alone of all of them could be taken as having given a fair season's growth, the grass derived from 250,000 tons of sewage would have been not 2500 but 3250 tons of grass, or exactly 1 ton for 100 tons of sewage over and above the 750 tons of grass which we may suppose the 55½ acres of land, unassisted by manure of any kind, would, under an Essex climate, naturally produce.

"The application of the sewage to root crops obtained results many times that which was obtained from grass land.

To be continued.

THE SMITHFIELD CLUB SHOW, 1868.

The display of machinery and implements this year at the Smithfield Club Show exceeds in extent, we believe, that of any previous year, but the novelties were by no means proportionate to the increased number of exhibits; indeed, little room is left in this branch of industry for any striking improvement or feature of novelty, although in minor details improvements are constantly showing themselves. Since our last visit the available floor space in the galleries of the hall has been considerably augmented, an addition of 13 feet having been made to the side galleries by extending them to the front of the main girders. By this means accommodation is afforded for an additional row of stands in each of the side galleries.

Amongst the heavier class of machinery on the ground floor, we noticed a self-propelling agricultural engine, exhibited by Garrett and Sons, of 8 horse-power. It is well arranged, and we need not say the workmanship is excellent. These engines were intended as substitutes for the ponderous traction engine, which is frequently the only available power for transporting thrashing machinery and straw elevators, and such like implements, which could readily be conveyed by an engine of smaller power. Messrs. Garrett's engine (fig 1) is only about one-half the size of an ordinary traction engine, and very little heavier than a common portable engine of the same power. These exhibitors had also several portable engines of various powers, embracing the numerous improvements for which this firm has long been justly celebrated. Richard Hornsby and Sons exhibited some excellent reapers and mowing machines. Their patent "governor" self-raking reaper has been considerably improved since we last saw it. An extra shaft has been added, in order to take off the weight from the horse's neck and transfer it to the back, by which the draught is greatly lightened. A driver's seat has also been added, and the driving gear, with change wheel motion, has been re-arranged and rendered more central and compact. W. Tasker and Sons still sustain their well-earned reputation for Finishing thrashing machines with all the most useful appliances, an excellent specimen being exhibited by them, along with some well-made winnowing and corn-dressing machines. Their greatest novelty this year is an 8 horse-power portable single steam-engine, fitted with their patent adjustable, eccentric, steam-jacketed cylinder and feed-water heater. The adjustable eccentric is a very ingenious and practically useful arrangement; it consists really of one eccentric fitted inside another, and both being made adjustable on the shaft, it follows that the amount of eccentricity may be regulated to the greatest nicety. The eccentrics when adjusted are held fast by a bolt, as shown in the annexed cuts (figs. 2 and 3), passing through a fixed plate or collar on the crank shaft, and also between coinciding semicircular notches made in the periphery of the inner eccentric and the interior of the outer one. In the cuts A is the inner eccentric, B the outer one, C the fixed plate or disc keyed on the crank shaft, and D—E is the pin or bolt and nut which secure the eccentrics in position. John Fowler & Co. had some workmanlike steam ploughing and cultivating machinery, comprising a 14 and a 10 horse-power steam-ploughing engines, a 6-horse furrow balance plough, and a new cultivator, which is specially adapted for light land, and intended for being worked by the double-engine sets of tackle. To each engine is attached a short piece of chain, and on the cultivator arriving at the headland the ploughman hooks this chain to the side of it farthest from the smoke box; the engine then moves forward a few yards along the headland and pulls the cultivator half way round, at the same time lifting the tines out of the ground by means of a lever to which the chain is connected. A latch releases the chain from the cultivator, and the opposite engine then commences winding, bringing the implement completely round into fresh ground. The ploughman allows the tines to drop into the earth, and the implement goes back to the other end of the field, where the same process is repeated. If we mistake not, this or a very similar idea was suggested by Mr. J. A. Williams, of Baydon, many years ago.

Fig 1.

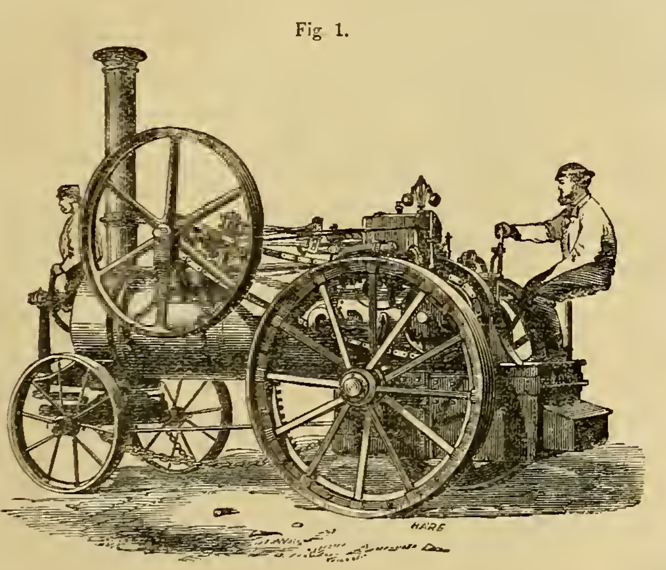


Fig 2

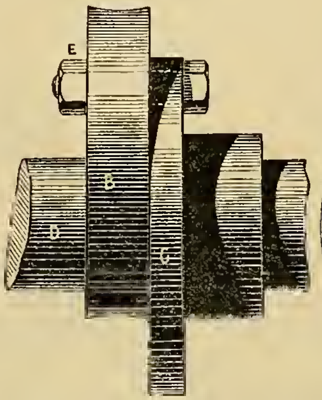
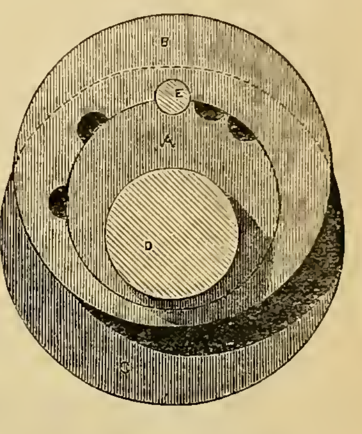


Fig. 3.



Charles Burrell, of Thetford, exhibited a 10 horse-power traction engine, with double chain gearing, and a novelty in the shape of a patent clover and trefoil seed-drawing machine, wherein the clover or trefoil is passed over a screen, which separates extraneous seeds before entering the sheller. In passing through the sheller most of the seeds are extracted from the husks the first time. It is then carried up by elevators to a dressing machine, which separates the chaff from the seed. The seed which escapes with the unshelled seed is passed over another screen, and taken out by a spout, so as not to enter the sheller the second time with the unshelled seed. This machine is said to possess the advantages of not breaking the seed, the effecting complete separation of extraneous seeds, and the preserving of the chaff uninjured for feeding purposes. Clayton, Shuttleworth, & Co., as usual, make the largest and best display of steam engines, comprising fixed, horizontal, portable, and traction engines. We also noticed here some rolled steel beater plates, made, we believe, under a patent of Mr. William Gray, of Sheffield. Messrs. James & Frederic Howard exhibited one of their improved water tube boilers, some steam cultivators and harrows, and an improved 12 horse-power patent traction and ploughing engine. In this engine the boiler, which is placed transversely to the frame, is made extra strong, and the hauling drums are situate one at each end of the frame, being driven from the crank shaft placed *under* the boiler and parallel with the main framing, the cylinders being also situate underneath the boiler and parallel thereto, in lieu of, as in their first arrangement, upon the *top* of the boiler, which is now furnished with a steam dome; this gives a much neater and more compact appearance. The coiling motion has also been improved, the drums traversing to and fro along their axes by a screw movement, worked by the rotation of the drums themselves. We also noticed Howard's patent 2-horse British mower (fig. 4), which is remarkable for its compactness and the simplicity of its construction. The driving shafts move in the same plane as the knives, and the connecting rod delivers a direct thrust to the cutter bar, which is so attached to the main framework by the "drag bar" that it can be readily controlled, whilst in motion, by a lever close to the right hand of the driver. By hanging the finger bar to the rear of the driving wheels, the driver can see obstructions before the fingers come in contact with them, the danger of the horses backing on to the knives is avoided, a better rising or accommodating action to any irregularities in the surface of the ground is afforded, and the machine can be readily changed into a good self-delivering reaper. Adjoining this mower was a 2-horse British reaper (fig. 5), with self-acting delivery. Like the mower above-mentioned, the reaper is mounted on two travelling wheels, whereby firmness and steadiness are imparted to the whole machine. As these wheels operate either together or independently, greater facility is afforded for making short turns without clogging or stopping the knives; whilst the necessity for stopping, in order to back the machine at the corners, is obviated. The self-reaper is driven by gearing independently of the cutters, and the gathering arms take hold of the standing corn at the same height from the ground as the rakes. By the use of a double concentric crown cam for regulating the motion of the rakes and gatherers, the gathering arms are allowed to drop suddenly down into the grain to bring it forward to the cutters, and to rise again so as to pass clear of the cut grain on the platform.

Fig. 4.

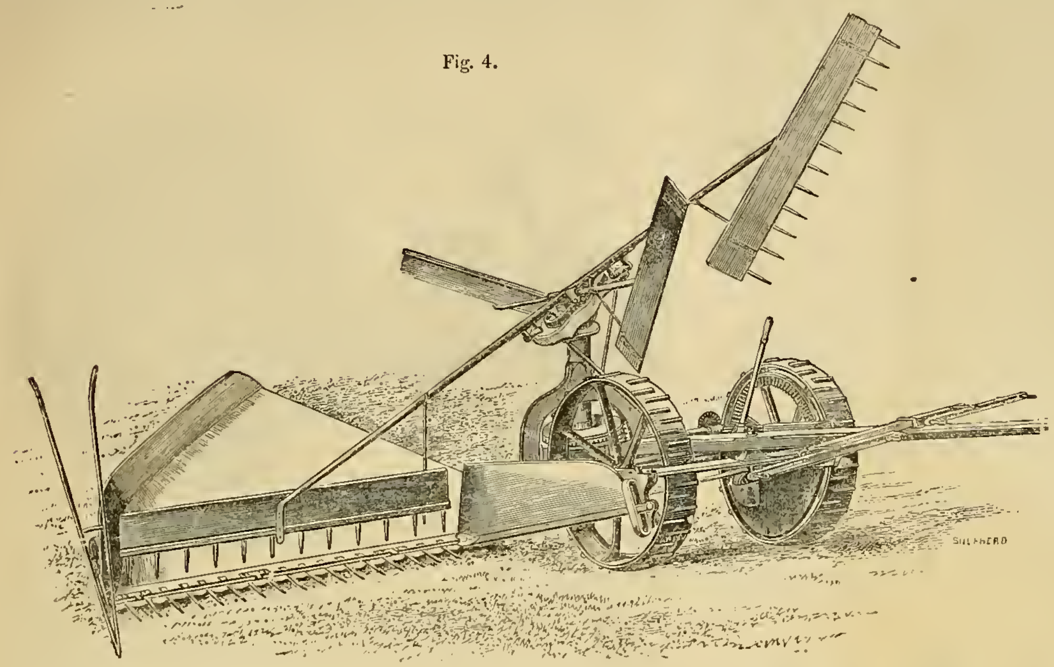
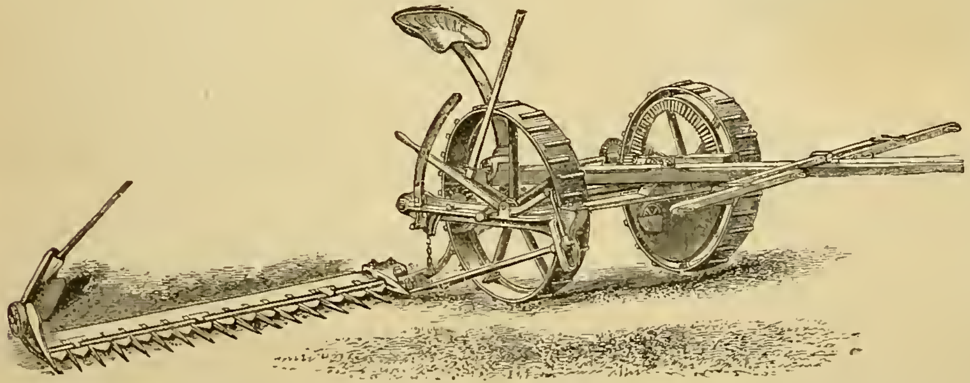


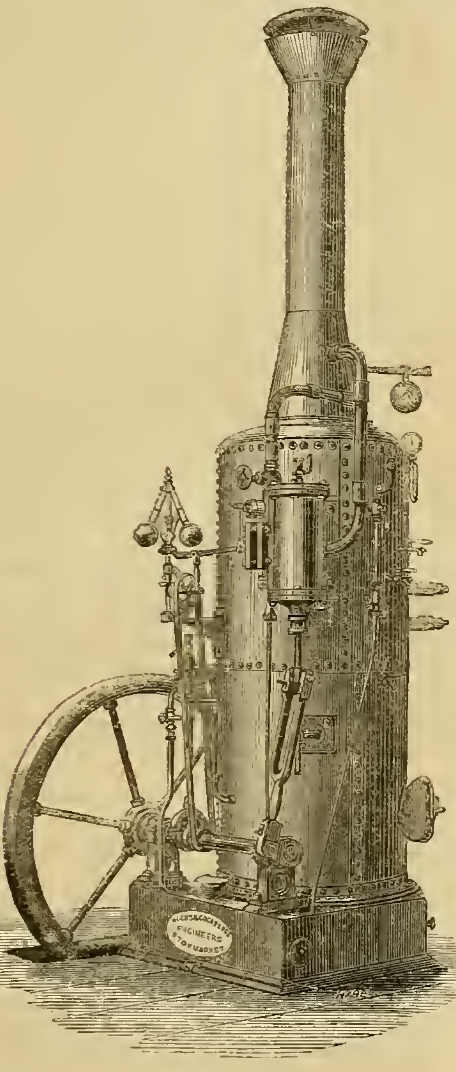
Fig. 5.



Messrs. Holmes & Sons exhibited an 8 horse-power portable steam-engine, a well-arranged thrashing machine, a pair of corn dressing machines, and various descriptions of drills, both for seeds and manure. The Beverley Iron & Waggon Company (Limited) made a large display of implements, including the royal Leicester first prize clod crusher, provided with cast-iron discs, each alternate one being about three inches larger diameter than the rest, and the several discs are formed with lateral teeth, as well as with the serrations on the periphery, which act perpendicularly in breaking clods; also a 1-horse manual delivering reaper, a 2-horse grass mower, and an exceedingly neat and well-made pair of Norfolk's iron wheels and axles, in which the naves are of chilled cast iron, and the spokes are of bent wrought iron, cast therein. E. R. & F. Turner, of Ipswich, exhibited a 10 and a 5 horse-power portable, two combined thrashing machines, and their usual collection of crushing mills and oil-cake breakers, for which this firm is celebrated. A well-made 12 horse-power patent steam-ploughing engine was exhibited by Aveling & Porter; also an 8 horse-power agricultural locomotive. William Allchin & Son were well represented by an 8 horse-power steel boiler portable engine, and a 3 horse portable, with Lowmoor iron fire box. Ransomes & Sims exhibited two 8 horse-power portable steam-engines, and several of their celebrated improved ploughs; also a large collection of Riddell's improved bean and oat mills. Ashley & Jeffery had a large and varied display of implements, including a 6 horse-power portable, with a very simple motion for adjusting or varying the stroke of the valve. The valve spindle is jointed to an upright vibrating lever, which has several pin holes made therein, to any of which the end of the eccentric rod can be readily adjusted, by simply withdrawing the front pin and re-inserting it in another hole. The farther the connection with the eccentric rod is situate from the fulcrum of the vertical lever, the smaller will be the traverse of the valve, and *vice versa*. Ruston, Proctor, & Co., exhibited a 12 horse-power double cylinder portable, fitted with Chapman's variable expansion eccentric, and an 8 horse-power single cylinder engine; also an excellent corn-grinding mill, with two pairs of 3 feet 6 inches stones. Woods, Cocksedge, & Warner had a 1 and 2 horse-power vertical steam-engine and boiler (fig. 6), which are serviceable and cheap; also a large collection of miscellaneous implements, including grinding mills, crushers, root graters, horse mangers, carts, and other farm appliances. Marshall, Sons, and Co. exhibited a double-cylinder 10 horse portable steam engine, an 8 and a 5 horse single-cylinder portable, with a well-arranged combined Finishing thrashing machine straw elevator, and some good specimens of circular saw benches. An excellent five-feet combined Finishing thrashing machine was exhibited by Nalder & Nalder (Limited), of Wantage, fitted with Nalder's well-known cylindrical screen, and all the most recent improvements. A fine collection of farm carts and waggons was exhibited by William Crosskell & Sons, in company with some good specimens of clod crushers and field rollers; also some useful farm railway trucks, tipping sideways. Last but not least of the down stairs exhibitors on our list, we have to notice the exhibits of John Tye, of Lincoln, comprising one of his well-known double mills, with two pairs of 3 feet 6 inches stones, and a single mill, fitted with one pair of stones of the same dimensions.

The galleries were very full, but as usual the display here was of a more heterogeneous nature. Following the order of the stands, but giving a passing glance here and there only, for our space will not admit of a detailed notice of the extensive collection to be met with here, we may mention the extensive collection of iron barrow-pumps and barrows of Alfred E. Peirce, of Hatton Garden, which are admirably adapted for the rough usage of the farm yard. Penny & Co. exhibit several of their adjustable corn screens. An interesting display of veterinary surgical instruments, far too numerous to particularize, is made by Arnold & Sons, of West Smithfield. Joseph White & Co. exhibit several of their S LV oil-feeders, provided with an internal valve for stopping the inner mouth of the exit pipe. These little appliances will be found most useful for domestic purposes as lamp-fillers, the closing of the spout by an internal spring and lever preventing any escape of effluvium when not in actual use. E. J. Davis, of Globe Wharf, exhibits some good specimens of compressed cattle food and fodder. The applications of enamelled slate, exhibited by H. & J. Ferguson, are well worthy of notice; for dairy and stable fittings nothing could be cleaner and more durable. We noticed a well-designed centrifugal pump, exhibited by John and Henry Gwynne, of the Hammersmith Ironworks. This pump will supply 4000 gallons per minute, with a lift of 15 feet. It has been constructed for supplying the surface condensers of the engines of the Brazilian mail-packet service, but would be equally useful as a drainage pump. The workmanship is admirable, and reflects the greatest credit on the constructors.

Fig. 6.



Holgate & Co., of Dover Road, exhibit some good specimens of mill bands, hose, and buckets. J. B. Brown & Co. have several well-made lawn mowers, and some good specimens of ornamental and plain iron fencing, with two handsome pairs of wrought-iron carriage gates. Chaff cutters are well represented by James Cornes & Co., who have long devoted considerable attention to this useful class of implement. Moser & Sons, of High Street, Borough, exhibit several of Bowden's patent forges, which have been extensively introduced into her Majesty's dockyards. Messrs. Tangye Brothers & Holman exhibit several useful steam and other pumps, and a 4-horse horizontal agricultural steam engine. A model of Amies, Barford, & Co.'s straw elevator is exhibited by that firm, in company with their celebrated land and water ballast rollers. Burgess & Key make their usual good display of reaping and mowing machines, which are now so well known to the agricultural world. We noticed an improved lawn mower, with appliance for trimming or finishing the edges, at the stand of Samuelson & Co., of Banbury, in company with their celebrated reapers and mowers. H. E. Ransome & Co., of Essex Street, exhibit several of Weston's ingenious mechanical appliances for raising and lowering weights, some of the most recent of which we shall shortly have the pleasure of laying in detail before our readers. Kittoe & Brotherhood are well represented by specimens of their "Paragon" steam pumps, which are both simple in construction and effective in action.

The display of oil-cake mills, seed crushers, root cutters, pulpers, and slicers by E. H. Bentall, of Maldon, is one of the best in the show. A small model of Dickson's double drill turnip cleaner is exhibited by Thomas Hunter, of Maybole, N.B. This machine cleans both sides of two drills at one operation. It has received several prizes at different shows this year, and is undoubtedly a most useful and inexpensive implement. Some excellent and well-made specimens of leather driving straps were exhibited by the Tanned Leather Company, Mark Lane. F. Morton & Co. exhibit several models, showing the application of iron roofing for various purposes; also their park and farm fencing. G. O. Gooday, of Chelmsford, has a multiple needle sewing machine, for stitching straw for farm rick and other coverings. This will be found a most useful machine; it is exceedingly simple, strongly made, and not liable to derangement, with ordinary care. It is capable of producing a web of stitched straw four feet in width, at the rate of 1000 feet per hour. The exceedingly delicate weighing machines of David Hart & Co., Whitechapel Road, are well worthy of notice. These machines were used in weighing the live stock exhibited this year, and are marvellous for their extreme accuracy. A machine capable of weighing three tons is instantly turned by half an ounce weight. Another important advantage of these machines is that loose weights are entirely dispensed with.

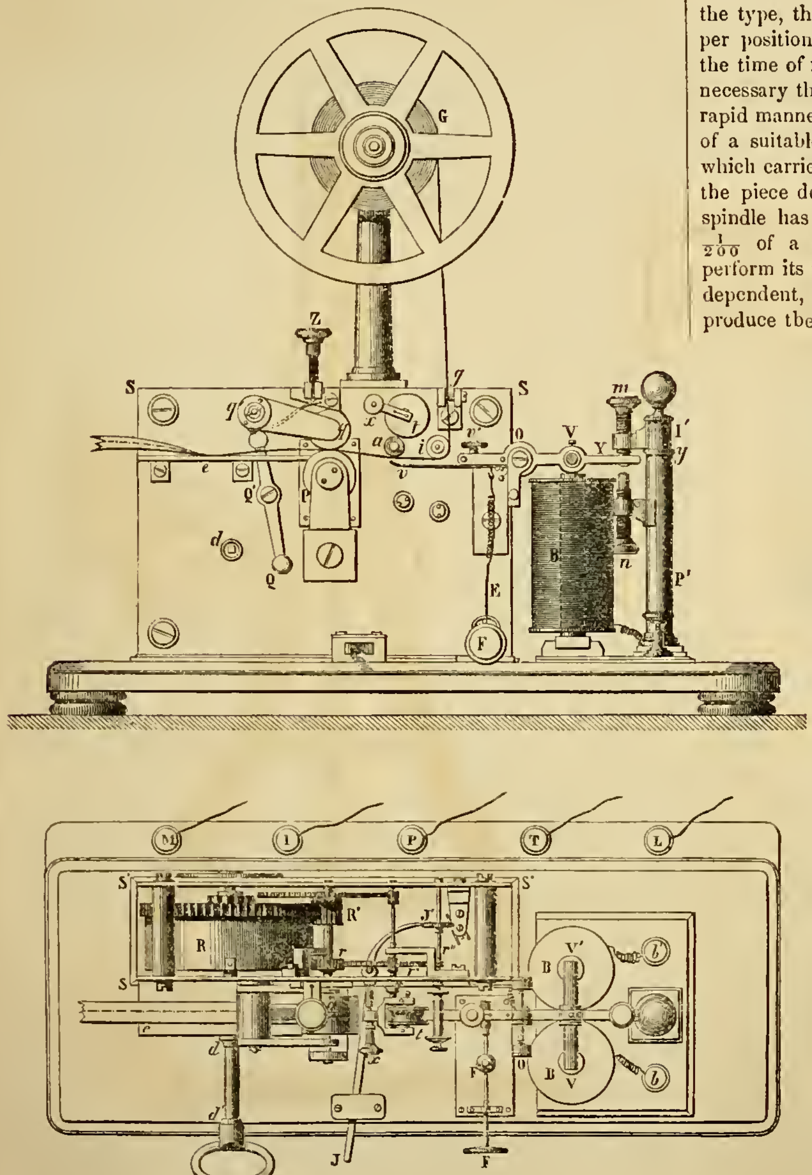
Some ingenious models of machinery and apparatus for facilitating harvesting in wet seasons were exhibited by Mr. William Alfred Gibbs, of Gilwell Park, Essex, the recipient of the Society of Arts' gold medal and prize of 50 guineas, as the author of the best essay on "Harvesting Corn in Wet Seasons." Mr. Gibbs proposes to blow warm air into the sheaves, which are placed for that purpose upon perforated conical tubes, fitted into a species of false floor, in an iron shed or wheat-house; the space beneath the floor being supplied with hot or cold air, under pressure from a fan blower. The corn sheaves or dried hay are elevated by a species of "puff and dart" action; that is to say, they are introduced into the lower end of an inclined air tube and literally blown up and out at the top into the rick, by a blast of air, generated by a fan blower at the bottom of the tube! Messrs. Riches & Watts, of Norwich, exhibited some useful grinding mills, for steam, horse, and hand power; also an improved water cart, and models of a new sheep rack and self-acting American horse rake; the last-mentioned being a very simple and ingenious contrivance for readily clearing the rake, and for preventing any accident from the backing of the horses on to the teeth, and avoiding all risk of injury to the attendant. Henry Denton, of Wolverhampton, exhibits an adjustable chain harrow, mounted on a carriage. It is carried to and fro and worked, wholly o rin part, by means of a windlass mounted on running wheels, and can be easily managed by a boy. By winding up or letting off more or less chain, the harrow can be readily adjusted to suit different soils. John Warner & Sons make their usual good display of hydraulic appliances, in the shape of pumps of all kinds. We noticed here some of Rooker's cutting beer taps, the advantage of which is that no mallet is required for driving it into a cask; this operation being effected by simply pressing the cock against the cork in the tap-hole, and turning it round at the same time, when the sharp cutting end of the tap will make a clean cut through the cork, without the escape of any of the liquid contents.

Picksley, Sims, & Co. exhibit several good chaff-cutters, some of which are provided with appliances for cutting two lengths of chaff without change wheels or stopping the machine. Garden engines are well represented at the stand by Haynes & Sons, where Robin's "Hydronette," a variety of garden squirt, is shown in operation. This is a very simple little contrivance, and a great improvement on the ordinary clumsy and leaky appliances hitherto adopted. It consists of a brass tube or cylinder, to be held in the left hand, and which is connected at the rear end with a short flexible tube, dipping into an ordinary pail. Within this tube slides fluid-tight, but easily, another tube provided with a rose or other jet, and worked to and fro inside the outer tube by the action of the right hand. A passing glance, as we take our departure, at the somewhat incongruous collection of miscellaneous exhibits to be met with in the arcade adjoining the main hall must close our notice. Here are to be met with potato peelers and ornamental root carvers, Wanzer sewing machines, patent soap, umbrellas warranted not to turn inside out in the stiffest gale, prepared cattle food, fish manure, waggonettes, dog carts, and children's toys. By a very sensible and stringent rule of the present show, miscellaneous articles like these are excluded from the official show which is rigidly reserved for implements having a direct bearing on agriculture.

TELEGRAPHY.

Mons. Lacroix's excellent *Etudes sur l'Exposition* contains an article upon the telegraphic apparatus in the late Paris Exhibition, from which we extract the following description of the most interesting instruments.

Fig 1.



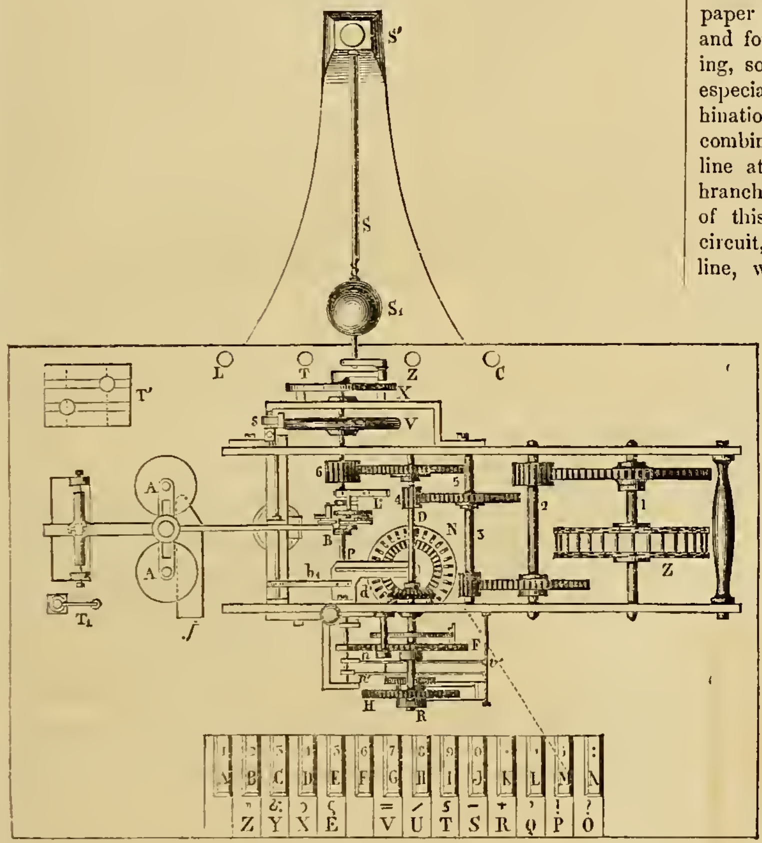
Digney & Baudoin's Writing Telegraph.—Fig. 1 shows in elevation and plan, this arrangement of telegraph; *a* is the writing medium; *t*, the inking roller to supply the latter with ink; *x*, the axis of the lever which carries it; *q*, *q'*, P, the rollers which feed the strip of paper along as the operation proceeds; *i*, *g*, *e*, the guides for the paper; *z*, the screw which presses on the spring of the upper roller, *q*; Q, the rocking lever employed to elevate that roller when it is required to use the apparatus as speaker or translator; *v* is a species of blade which presses the strip of paper against the writing medium in order to produce the impressions; *v'* is an adjusting screw to regulate the pressure of the blade; B is the electro-magnet, V its armature, O the fulcrum of the lever which carries it together with the blade, *v*; E, the counter-acting spring, and F its whim; *m*, *n*, the two screws of the translator which are carried by the pedestal I' P'; G, the wheel on which the paper is wound; SS, the box containing the clockwork; J, the detent; *d'd*, the key to wind up the mechanism.

Hughes' Printing Telegraph.—The object of Mr. Hughes' improvements is to produce the impressions while the apparatus is in motion, thus obviating the necessity for rests or intermissions during the operation of printing the letters, and effecting a considerable saving in time, with other advantages. In order to insure the synchronism of the apparatus, which might be affected by this system of printing, a wheel, termed a correcting wheel, is provided on the same axis as that carrying the type, the object of which is to re-adjust the latter wheel to its proper position after each impression, so that any delay taking place at the time of making the impression is immediately corrected. It is also necessary that the operation of printing should be performed in such a rapid manner as to insure the characters being clear and distinct, and of a suitable distance apart. This is effected by disposing the wheel which carries the type on the last spindle but one of the apparatus, and the piece destined to produce the impression being adapted to the last spindle has been so arranged as to perform its eccentric motion in $\frac{1}{200}$ of a second, whilst the type wheel takes half a second to perform its revolution. These two motions being, moreover, mutually dependent, the correction required is readily obtained. In order to produce these effects very powerful clock mechanism is required, and corresponding electrical power to actuate the same. For this purpose Mr. Hughes employs electro-magnets at their maximum of power; that is to say, with their armature in contact with the poles. In this manner the action of the electro-magnets is produced only by the effect of the destruction of their magnetism; and as the armature can be mechanically brought again in contact with the electro-magnet, the electric action may be said to be increased a hundred fold. Mr. Hughes has also improved the mechanism by which the rotation of the type wheels at both stations is synchronically effected. A heavy fly wheel is fitted on to the first spindle, and the latter is made to act on a vibrating rod, so as to cause it to perform circular vibrations. As is well known, with vibrating rods of a given length and inertia the vibrations are so isochronous that, notwithstanding marked differences of amplitude, the sounds that they emit do not vary. It is simply requisite then to adapt to these rods a regulating system, and a brake destined to deaden the motion of the mover, in order to obtain with this system a perfect synchronism in the motions of the apparatus. For the regulator Mr. Hughes employs a heavy ball which is carried by the vibrating rod, and may be adjusted to any position thereon, and the brake he uses is a friction brake, which is applied to a wheel on the last spindle of the apparatus.

Fig. 2 shows the arrangement of the apparatus. Z, 1, 2, 3, 4, 5, 6, are the different wheels of the clockwork; V, the fly wheel placed on the last spindle; SS', the vibrating rod, which moves circularly; X, the regulating brake; *s*, the brake of the fly wheel, which acts as the detent of the clock work; B, the detent of the electro-magnet; AA, the electro-magnet; H, the type wheel; F, the correcting wheel; R, the roller which guides the strip of paper; *n'*, the cam which elevates the roller, and effects the impression in $\frac{1}{200}$ of a second; *m* the cam which acts on the correcting wheel, and the snail-like cam which feeds the strip of paper along; N, the circular interrupter which is put in action by the keys of the key board; T T′, the commutator; *f*, the armature of the fixed magnet carrying the electro-magnets, A A.

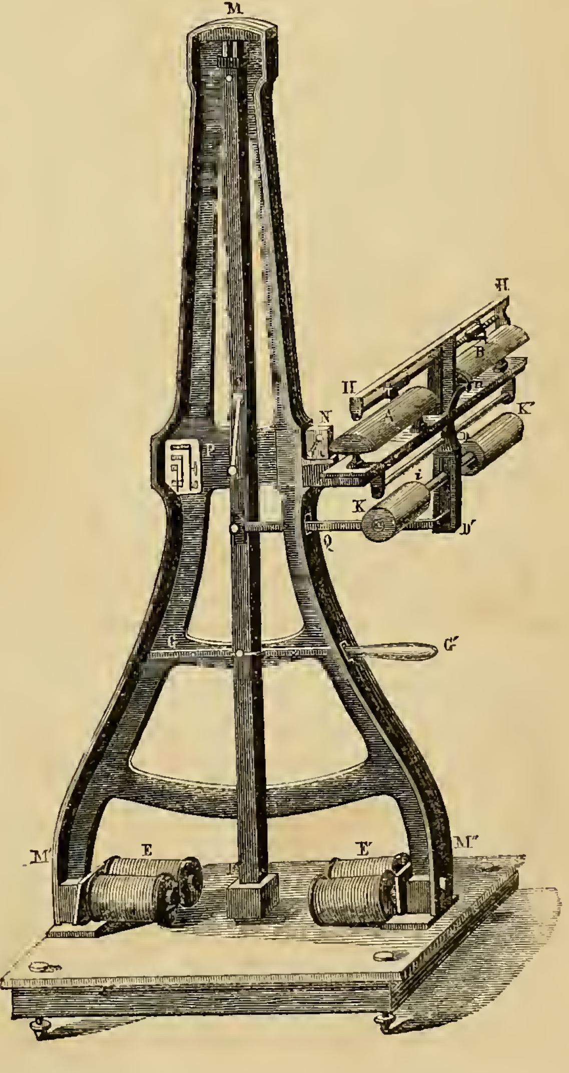
Caselli's Autograph Telegraph.—Autographic telegraphs are composed of three different parts, viz., a driving mechanism, a registering mechanism, and an apparatus for regulating the synchronism. In the latest examples of Caselli's telegraphs, the driving mechanism is composed of a long pendulum, F F′ (fig. 3), the ball of which consists of a heavy mass of mild iron, F′, which vibrates between the electro-magnets, E E′, destined, not merely to maintain its motion, but also to retard the commencement of the vibrations when they are not performed in a synchronous manner in both apparatus. The registering mechanism is connected to the pendulum by two rods, the effect of which is to cause the rocking system, H H D′, to oscillate. This rocking system carries a movable slide, and an arrangement of click and spring work destined to act at each vibration on an endless screw so as to cause it to turn intermittently. A species of nut adapted to the movable slide, and applied to the endless screw, effects the motion of the slide at each oscillation of the rocking system, so that a style carried by the slide will describe a series of parallel arcs of circles, the interval between which is determined by the proportion between the number of teeth in the ratchet wheel of the click arrangement and the pitch of the endless screw. A species of drum or semi-cylindrical plate is provided beneath the style, which plate is secured to a table which forms part of the frame of the apparatus. When the apparatus is a transmitter, a sheet of paper having metallic foil attached thereto is fixed on to this drum, and on this foil is written with ink the despatch it is required to transmit. When, on the contrary, the apparatus is a receiver, there is disposed on the drum a damp sheet of paper, saturated with a solution of ferrocyanide of potassium and azotate of ammoniac.

Fig. 2.



Suppose now that at two corresponding stations the apparatus are regulated so as to work synchronously, and that one is disposed for receiving and the other for transmitting; the moving points or styles will then describe not only the same arcs, but the same portions of those arcs, in the same instants. The result is, that if the styles and the sheets applied on the drums of the registering apparatus are connected with the circuit of the line, there is produced, in proportion as the point of the transmitter traverses the writing, a series of current openings which correspond to the points occupied by the ink, and are capable of re-acting electro-chemically on the prepared paper placed on the drum of the receiver by the intermedium of the style which traverses it. If this re-action were simple like that just described, all the parts of the prepared paper corresponding to the metallic portions of the despatch transmitted would be occupied by series of blue lines, in the midst of which the interruptions of the current determined by the ink traces would produce in blank the fac-simile of the despatch: for under the influence of the current the ferrocyanide of potassium with which the damp paper is saturated combines with the iron of the writing point or style, and forms Prussian blue. As, however, the blue traces in spreading, somewhat obliterate the white traces reproducing the writing, especially when it is rather fine, Mr. Caselli has contrived a combination of current which realizes the opposite effect. This combination consists in establishing the transmitter no longer on the line at its connection with the pile at the positive pole, but on a branch established between the line and the zinc pole. The effect of this is that when the transmitter produces an interruption of circuit, the current is conducted directly and entirely across the line, whilst, when the contrary takes place, there is established a derivative local circuit of slight resistance, through which almost all the current passes, since it offers infinitely less resistance than the line circuit.

Fig. 3.



The mechanism for regulating the synchronism consists of a simple clock movement regulated at each station by a pendulum, and which acts on a rheotome put in connection with the circuit of the line before each vibration of the driving pendulums, and at the same time with the electro-magnets destined to regulate the times of the motions of the latter. The motions of these driving pendulums being thus rendered completely dependent on that of the regulating chronometers, the operations of both apparatus are performed in a synchronous manner.

DIRECT-ACTION STEAM-PUMP.

(*Illustrated by Plate* 12.)

The exceedingly compact and simple direct-action steam-pump, which we now illustrate, is the invention of Mr. William Tijou, C.E., of Great George Street, Westminster. We recently inspected Mr. Tijou's pump in operation at the engineering establishment of Messrs. Whieldon, Lecky, & Lucas, Westminster Bridge Road, and can speak with confidence of its efficiency, and of the great regularity and smoothness of its action. Of its simplicity and the ready access afforded to all the working parts, our readers can judge for themselves from our plate engraving, prepared from the working drawings. Fig. 1 (Plate 12) represents a longitudinal sectional elevation of Mr. Tijou's pump; fig. 2 is a corresponding plan of the same; fig. 3 is a transverse vertical section taken through one of the steam ports in fig. 1; fig. 4 is a similar section taken through the exhaust port; and fig. 5 is a vertical section taken through the middle of the rocking frame which actuates the valve; A is a cast-iron bedplate, on one end of which is cast the steam cylinder, B, the working piston rod, D, being prolonged so as to form the plunger of the pump, which is cast on the opposite end of the bedplate, the working cylinder, pump barrel, and bedplate thus forming one casting. The working cylinder has the usual steam ports, *a*, *a*, and exhaust port, *b*, cast therein, which are governed by the peculiar cylindrical valve, E, working inside a corresponding valve case, F, shown more clearly in the transverse sections, figs. 3 and 4; *c* is a cavity or chamber made inside the valve, which is in constant communication with the steam in the boiler through the steam-pipe, G. At different angles from this central cavity are formed radial openings, *a′*, *a′*, and in a longitudinal line with each of these openings, but in reversed positions, there is formed a recess or chamber, *b′*, in the metal of the valve, which chambers serve to connect one or other of the steam ports with the exhaust port, according to the direction in which the valve is turned; *d* is a chamber formed partly round the valve on the side opposite to the steam and exhaust passages for the purpose of saving material and reducing the area of the rubbing surface. The valve spindle, H, works through a stuffing box, *e*, in the valve case, and is coupled at *f* to a rocking spindle, I, which works in bearings, *g*, *g*. This rocking spindle has keyed thereon the segmental frame, K, and centre guide piece, L, both of which are so shaped as to form a differential endless slot or groove, *h*, which is seen more clearly in the plan. Within and along this slot, *h*, works the antifriction roller, M, carried on the lower end of the arm, N, which is keyed on to the piston rod, D. An eye is made in the upper end of the arm, N, which slides to and fro along a guide rod, O, extending between and secured to the cylinder and pump barrel respectively. With a view to insure smoothness and to avoid noise or jarring when at work, the antifriction roller or bowl, M, is provided with elastic material in the centre so as form a spring roller, or it may be made of lignum-vitæ or of compressed leather; and the slot, *h*, is cut in a piece of hard wood, compressed leather, hard india-rubber, or other similar material, held between two sheet metal plates. On admitting steam to the cylinder, with the valve in the position shown in fig. 1, the piston will be forced outwards, driving at the same time the piston or plunger of the pump inwards, the exhaust taking place through the opposite steam port and through the recess or chamber, *b′*, in the valve which connects it for the time being with the exhaust port, *b*. During the time the piston is moving outwards the bowl, M, is travelling along the straight portion of the differential slot, *h*, the valve consequently remaining stationary for a time; but by the time the piston has nearly completed its stroke the bowl, M, will have entered the curved portion of the slot, *h*, and will thereby cause the frame, K, and centre guide piece, L, with the rocking spindle, I, to rock or turn over to one side; the extent of such rocking motion being sufficient to bring the other valve port and recess into action, thereby admitting the steam to the front end of the cylinder and exhausting from the rear end. This position of the valve is maintained so long as the bowl, M, is travelling back along the straight portion of the slot, *h*, on the opposite edge of the frame to that by which it had last travelled; but whilst the bowl is moving along the curved portion of this slot the valve will be turned partially, and will have assumed its original position, shown in fig. 1, by the time the piston has completed its stroke, the movements being then continued as already described. The peculiar valve above described, and mode of operating the same, are obviously well adapted for use in steam-hammers, and in steam-engines provided with reciprocating pistons.

Recent experiments have led Mr. Tijou to alter slightly the form of the differential slot given in our engravings, he having found that by imparting rather more curve to the sides of the slot, so as to cause it in fact to assume more the form of a slightly distorted ellipsis, he not only increases the smoothness of the valve motion, but obtains both lap and lead in the valve, a rather remarkable result to be attained without the aid of an eccentric. He has also added a small spindle and hand wheel, shown under the pump barrel (fig. 1), for the facility of starting or moving the valve by hand, the spindle having a square end, which fits into a corresponding recess made in the end of the rocking spindle, I. The principal dimensions are—diameter of working cylinder, 3 inches; length of stroke, 5½ inches; diameter of pump barrel, 1½ inches; length of stroke, 5½ inches. With a steam pressure of about 55 lbs. the pump makes 300 double strokes per minute, and supplies very nearly 400 gallons of water per hour.

MECHANIC'S LIBRARY.

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ERRATUM.

At page 265, Part XLV. (December, 1868), article "Harvie's Lamps and Dioptric Lenses," for "John Harvie" read "William Harvie."

RECENT PATENTS.

CLEANING GRAIN.

Messrs. J. G. Walker, *of Bonnington Steam Mills, Edinburgh, and* Charles Stein, *of Leith.—Patent dated* 6th *May*, 1868.

This invention, which relates to an improved means by which impurities, such as tares and other foreign seeds or matter, may be separated from grain, pulse, and other similar produce, consists in employing a spout through which the grain, pulse, or other produce to be cleaned falls upon a cone. In travelling down the surface of the cone the tares or other impurities, from their form and size, acquire a greater momentum than the grain or pulse, and on arriving at the lower end of the cone they fall over the ledge there situated, whilst the grain or pulse having a less momentum, and being also to some extent impeded by its form, does not fall over the ledge, but passes through openings into the interior of a hollow inverted cone, on arriving at the centre of which it escapes through a hole and passes over another cone similar to the first. Under this invention any number of cones may be employed, according to the extent of cleaning the seed under treatment may require.

Fig. 1 of the engravings is a vertical section, and fig. 2 is a half sectional plan, of an improved cleaning apparatus for removing impurities from grain and other seeds, according to this invention. The apparatus consists of two cones, A, B, which are supported by the brackets, C, placed on the vertical spindle, D, and fixed on it by pinching screws, *a*, so that the cones, A, B, may be raised or lowered at pleasure to regulate the vertical space between the bottom of these cones and the mouth of the inverted cones, F, G, which rest upon the brackets, H, supported on the framing, I. In operating with the apparatus the grain, pulse, or other produce is filled in by the tube, J,

Fig. 1.

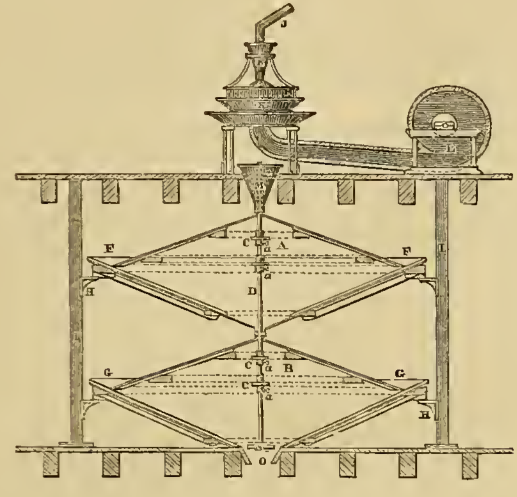
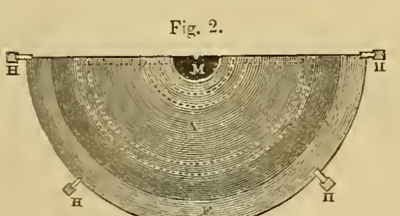


Fig. 2.



and falls through the funnel, K, into a cleaning chamber, K′, where it is cleaned from earth, dust, chaff, and other extraneous matter by means of a fan or air-box, L. The grain or other produce then falls through the funnel, M, and rolls down the surface of the cone, A, which is covered with tin plate or other suitable material, so as to present a smooth surface, on passing down which the tares or other impurities from their form acquire a greater momentum than the particles of grain; and on arriving at the bottom of the cone, A, they leap over the mouth or rim of the inverted cone, E, while the grain particles fall inside and roll down the inner surface of the cone to its apex, where it falls through on to the cone, B, down the smooth surface of which it passes, and any tares or other impurities which may remain in the grain are eliminated thereby, in the manner before described. The grain then passes down the surface of the inverted cone, G, and escapes by the spout, O. Instead of adjusting the cones, A, B, by means of the sliding brackets, C, they may be regulated by a screw placed in the foot-step bracket, N, so as to raise the spindle, D, or by means of slides, or other convenient manner. In some cases it may be advantageous to reverse the order of the process, and allow the impurities instead of the grain to fall inside.

RAILS, POINTS, AND CROSSINGS.

Edward Gray, *of Sheffield.—Patent dated 24th March*, 1868.

This invention relates to a peculiar and economical mode or method of strengthening or rendering more durable, the rails, points, and crossings of railways, and consists essentially in applying to or combining with the iron, before it is completely shaped or manufactured with the aforesaid articles, an outer skin or covering of steel as after described, so as to cover those parts which are subjected to the greatest wear and tear. For this purpose, the steel is applied to or combined with the iron, or cast on to it, by placing the heated iron in a mould or *moulds* of any desired shape and number of pieces, and pouring the melted steel over those parts of the wrought iron to which it is to be applied.

Fig. 1.

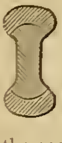


Fig. 2.

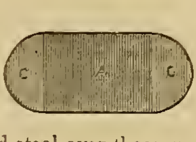
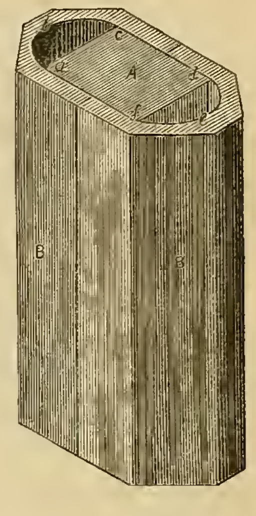


Fig. 1 of the engravings represents a transverse section of a double-headed rail, strengthened and rendered more durable according to the invention. Fig. 2 is a plan of a combined steel and wrought iron slab, steeled on both edges, from which the rail shown in fig. 1 may be rolled, and fig. 3 represents a cast-iron box or ingot mould or moulds, which is employed when casting the steel on to the wrought iron. The slab from which the rail is to be subsequently rolled is made by first forging a bar or slab of iron, A, of the required dimensions. This slab may be allowed to cool or not, to suit convenience, and then taking twenty or any number, and putting them in a suitable heating furnace to get hot by the time the steel in the crucible is ready for pouring, as it could not be steeled from the forging without being heated again. This wrought-iron bar or slab is then to be introduced whilst in a heated state into a metal mould or *moulds*, B, made to open longitudinally or otherwise, in one or more parts, by preference along each side of the wrought-iron bar or slab, as shown in the perspective view, fig. 3. The ends of the cavity in this mould or *moulds*, are by preference rounded, as shown at *b* and *e*, so that when the wrought slab, A, is introduced, a semi-cylindrical space, *a*, *b*, *c*, and, *d*, *e*, *f*, will be left on each side or edge of the slab, into which space or spaces (according as one or both edges of the slab is or are to be steeled), melted steel is poured from a crucible. This steel makes a perfect weld with the iron of the slab, and when removed from the mould, the slab, which will present the appearance shown at fig. 2, is ready for reheating preparatory to being rolled into the form of rails; the steel portions, C, C, of the slab coinciding with, and forming the whole or a portion only of the head or heads of the rails, as shown at *e*, *c*, fig. 1, according to the greater or less proportion of steel employed. It is obvious that, similar combined iron and steel slabs may also be employed for producing the wing and point rails of crossings, and the tongue rail of switches.

Fig. 3.



METAL BARS FOR HORSE SHOES.

Edward Gray, *of Sheffield.—Patent dated 24th March*, 1868.

This invention consists in rolling bars of iron, or of steel alone, or of iron faced with steel, with a number of teeth or serrations made longitudinally, transversely, or otherwise, on one or more of the surfaces of such bars of whatever section they may be; the object being to obtain a bar suitable for the manufacture therefrom of horse-shoes or other articles, in which a roughened or dentated surface is advantageous. Horse shoes, for example, made from such bars will not be more durable, but will present a firmer foot-hold, and will not require sharpening or roughing in frosty weather, as the teeth or sharp points rolled in the original bar will prevent all tendency to slipping.

Fig. 1.

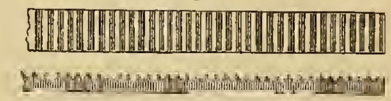
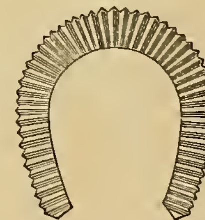


Fig. 1 of the engravings represents an underside and edge view of one of the improved bars, having a number of teeth, serrations, or sharp angular ridges, rolled transversely on one face thereof; and fig. 2 represents the same bar as bent into the form of a horse-shoe, showing the position or direction of the serrations or ridges, which in this case radiate from the central portion of the shoe. Although a solid steel bar only is shown in the engravings, sometimes these improved bars may be made with steel corrugated or roughened faces welded on to an iron back.

Fig. 2.



REVIEWS OF NEW BOOKS.

SHORT NOTICES.

L'Architecture Moderne en France, by M. F. Barqüe, Architect, with atlas of 120 plates, Noblet et Baudry, Paris, is worthy the attention of all practical house architects and builders in England, who will do well to become better acquainted with the skilful uses now made of iron and other durable materials in civic housebuilding in France, and with many conveniencies of arrangements internally, as well as grace and beauty of exterior elevation, to which we are in great part yet strangers.

The Maisons et Ecoles Communales de la Belgique (same publishers) is another work from which much may be learned as to the best details of construction in reference to health and facility of teaching, &c., in schoolhouses; our buildings for which in Great Britain are but too generally very bad samples, nearly always ill suited to their purpose, and often the really essential parts of the interiors sacrificed to external quaintness and trumpery in mediæval nonsense of miscalled architectural elevation.

A new and much improved and enlarged edition, for subscribers only, is announced by Guyot of Bruxelles, of the celebrated work of Colonel Brialmont on fortification, Etudes sur la Défense des Etats et sur la Fortification, published in 1863. If the promises made as to this new edition shall be fulfilled, in the way and to the extent that the author warrants our expecting, it will prove the most important work on its subject, into which railways and steam, rifled projectiles and breech-loaders, &c., have introduced such changes, that has yet appeared.

De l'Invention de la Porcelaine de France a Rouen en 1673, is the title of a pamphlet by M. Milet, the director of the Imperial Porcelain Works at Sèvres, being a reprint from an article of his bearing the same title, which appeared in the October part of last year in the *Revue de la Normandie.* The object is to establish, by historical evidence, the fact that Mons. Alex. Brogniart, in his celebrated work the *Traitê des Arts Ceramiques,* was in error in attributing the very earliest production of China, *i.e.,* true *porcelain tendre,* in France, to the very early manufactory at St. Cloud in 1695. M. Milet proves, with a good deal of weight, that this honour belongs to Normandy and to Rouen, where he shows that *porcelain tendre* was made in 1673, and refers to dated samples still forthcoming.

This pamphlet, published by Cagniard of Rouen, is an instance of the strong local feeling that still exists in Normandy, and is not without general interest to all concerned in ceramic manufacture, as the facts adduced indicate that about the end of the seventeenth century, when once the mind of Europe was excited by the importations of Chinese porcelain, attempts at its production were almost simultaneous in many countries, and in the hands of many different persons, and that independent success attended several of these.

A much larger work is now promised upon the ancient manufacture of porcelain in Normandy. This very year another, and a remarkable work, by M. Lejeal, Recherches Historiques sur les Manufacture de Faience et de Porcelaine de Valenciennes, with coloured plates, has appeared. In this the early history of the manufacture is traced further north and east, and into Flanders in fact.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

THE HEATON PROCESS.

We reprint the two following letters from the *Times,* as forming an appendix to the article on this subject in our last month's issue. Our readers must form their own conclusions upon the matter:—

"The Heaton Steel Process

"Denmark-hill, *Dec.* 1.

"Sir,—In your Money article of the 21st of October my name has been mentioned in connection with the Heaton steel process in a way which, however unintentional, has, I find, entirely misled a great many persons as to the facts of the case; and, coming as it does with the whole weight of a city article in the *Times,* I am sure you will gladly allow me a portion of your valuable space in order to explain the great difference between the steel made by the Heaton process and my own.

"The following is a portion of the paragraph referred to:—

"'A few years since Mr. Bessemer carried to a successful issue the pneumatic process which bears his name, for the manufacture of steel from pig iron; the Bessemer process, however, demands iron of the first brand, and is unequal to the conversion of iron of inferior qualities charged with impurities of phosphorus and sulphur in large quantities; in short, until very recently no marketable steel has been produced from Cleveland or Northamptonshire pig. Great interest is therefore stated to attach to the successful operation of a process patented by Mr. Heaton, of the Langley Mill, in the Erewash Valley, by which inferior iron is made into first-class steel.'

"Now, Sir, the inference which I find has been in many cases drawn from this paragraph is simply that Mr. Heaton can by his process produce, from a cheap and inferior pig iron, steel of a similar character to that obtained from a more expensive raw material by the Bessemer process. This is, however, far from being the case, for Bessemer steel is cast steel—that is, steel made into a perfectly homogeneous mass while in a fluid state—and to that circumstance alone owes its great value as a material for the manufacture of railway bars, &c. All cast steel, however it may be made, possesses this invaluable property of homogeneity and freedom from a laminated structure, and none other than cast steel has this peculiar property.

"It must also be borne in mind that the reason why a Bessemer steel rail is found to last out from ten to a dozen ordinary iron rails, is not in consequence of its hardness as steel, but because it owes its great durability to its entire freedom from that laminated or fibrous character common to all iron or steel which becomes mechanically mixed with slags or scoria in consequence of the solidification of the metal whilst its refinement is still going on, as is the case in the Heaton process, which cannot produce cast steel. In the Bessemer process, by simply forcing atmospheric air in numerous jets upward, through five tons of molten pig iron, for a period of fifteen or twenty minutes, the iron is converted into fluid cast steel; the oxygen contained in the air, uniting with the superfluous quantity of carbon present in the pig iron, produces an intense combustion, and raises the temperature of the metal to the extremely high point necessary to retain the steel in a state of complete fusion, without the employment of any additional fuel; the fluid thus obtained, when poured into moulds, forms a solid homogeneous mass of cast steel, entirely free from scoria or other mechanically mixed impurities.

"But in the Heaton process nitrate of soda mixed with sand is employed to generate the necessary amount of oxygen gas for decarburizing the pig iron, instead of employing the cheap gaseous oxygen of the atmosphere. Now, whenever solid substances are converted into gas, a vast amount of heat is absorbed and rendered latent; hence in the Heaton process so much heat is abstracted from the metal in generating oxygen gas by the decomposition of nitrate of soda, that the metal solidifies while in a state of mechanical admixture with the sand and soda, and thus, instead of obtaining fluid cast steel by his process, Mr. Heaton obtains only a lump of spongy, porous metal, intermixed throughout with slags and scoria, and having the general characteristics and properties of ordinary puddled iron or puddled steel, but which is only obtained at a cost (for nitrate of soda) of more than double that of the ordinary puddling process.

"The crude lump of metal obtained by the nitrate process may be hammered and rolled into bars, and be used as ordinary puddled iron or puddled steel, materials which from their nature and physical properties are entirely distinct from, and can never compete with cast steel. It is true that, in common with puddled iron of every description, Mr. Heaton's crude metal may be made into cast steel by resorting to the old and costly Sheffield process of melting in crucibles, a process which consumes about 3½ tons of coke for every ton of metal so melted, and with the additional cost of wages, crucibles, &c., this melting process alone costs from £5 to £6 per ton. Hence, although Mr. Heaton starts with a cheap pig iron, giving him an advantage of 20s. to 30s. per ton over the cost of the Bessemer raw material, he nevertheless employs for the conversion of one ton of pig iron (according to Dr. Millar's report) no less than 270 lbs. of nitrate of soda, which, at the present market price of 15s. per cwt., is equal to 36s. on the ton of crude iron, thus bringing up the cost of the materials employed in making a ton of crude steel by the Heaton process several shillings per ton above the cost of the high-class iron used in the Bessemer process; and when we add to the cost of the Heaton crude steel the additional cost of £5 to £6 per ton for melting, I think it will become as clear to the general public, as it has long been to all practical steel-makers, that the Heaton process can in no way compete with the cast steel at present in the market, either in price or quality.—I am, Sir, yours faithfully,

"HENRY BESSEMER."

"The Heaton Process.

"Langley Mill, near Nottingham, *Dec.* 10.

"Sir—In your Money article of the 2nd inst. I noted a most unwarrantable attack upon my process for manufacturing steel and wrought iron. I am surprised that a letter containing such a tissue of extraordinary allegations should have the authority of such a name as Henry Bessemer. The fact being as it is, however, I can but trust to your impartiality to concede me the privilege of reply. I am not used to letter writing, and my time is engrossed by visitors to the works. I shall therefore be as brief and clear as possible.

"Your notice, Sir, of the Heaton process appeared on the 21st of October. Between this and December the 1st, a period of six weeks, Mr. Bessemer was framing his attack upon me. You will, in common with the public, conclude that during this interval Mr. Bessemer was satisfying himself by personal inspection at my works of the correctness of the surmises he entertained, and which he has moulded into such reckless statements. The iron trade is quite familiar with the fact that the works here and the process itself were freely open to all the world; that any one could bring his own pig iron and see it converted into steel under his own eye, take it away with him, forge it, and subject it to mechanical tests, add up the cost of material and labour, and form for himself a practical conclusion upon the merits of my invention. This is what the impartial mechanical journals during the last two months have told everybody they might do; and, not to particularize by name what engineers and experts of the first position have done, it is what a French commission at no longer date than next week is about to do, but it is exactly what Mr. Bessemer has omitted to do.

"The main points, however, with which the commercial world are concerned in this matter are:—

"First, Can Heaton make steel as good as Bessemer's, and at a less cost, from the same materials, with a plant costing vastly less?

"Secondly, Can Heaton make good steel and iron from Cleveland and Northampton pig iron—from brands, in short, that Bessemer cannot use, owing to the presence in them of large quantities of phosphorus and sulphur?

"And, thirdly, Can he make good steel and iron as cheap, or cheaper, from the commonest pig as Bessemer can from the most expensive brands?

"The question of cost involved in the first proposition I will beg leave to treat, Sir, farther on. That the plant of my process costs next to nothing as compared with Mr. Bessemer's, is a positive fact. The whole of the small ironmasters can, owing to the trifling expense of my apparatus, enter now upon steel-making, from which they have been prevented by insufficiency of means to acquire the Bessemer plant and utilize their brands. The first question resolves itself, therefore, for the present, into my ability to make good steel cheaper than Mr. Bessemer from the same materials, and it has been begged altogether by Mr. Bessemer from the points of view both of theory and practice.

"Mr. Bessemer starts boldly enough by denying that I make cast steel at all, except by remelting in crucibles. He defines cast steel as 'steel made into a perfectly homogeneous mass while in a fluid state.' I affirm that my steel, which is made into a perfectly homogeneous mass while in a fluid state, is cast steel. It suits Mr. Bessemer to deny the fact, and he does it on the strength of a theory that the charge in my converter becomes cooled by the evolution of the oxygen of the nitrate employed. But it is really absurd to suppose that the small amount of heat of temperature abstracted from the molten metal to supply the evolved oxygen with its heat of fluidity is not abundantly compensated by the heat of combination resulting from the union of the oxygen with the carbon of the pig. The cooling effect he refers to is far outbalanced in his own process by the cooling effected in his converter by the prodigious volume of cold air forced through it for from twenty to forty minutes. Which will carry off most heat, such a volume of air, or the oxygen evolved from 224 lbs. of crude nitrate to the ton of steel?

"Were my charge really cooled, as represented by Mr. Bessemer, the desired amount of the contained carbon would not be eliminated. It would consequently remain cast iron, and no crucible melting could ever produce the steel which Mr. Bessemer himself admits is undoubtedly the product of such re-melting.

"Mr. Bessemer's theory is wrong so far; yet as it is mere theory I could forgive him. But when he proceeds to theorize over the necessary admixture of my steel with slag, when passing through his theoretic process of cooling, I can no longer afford such indulgence. Mr. Bessemer says his steel is a solid homogeneous mass, entirely free from scoria or other impurities, whereas mine is not, owing, he says, to the 'mechanical admixture with the sand and soda.' This is not the case. The slag, owing to its small specific gravity and to its extreme fluidity, rises to the surface of the molten metal, leaving the subjacent steel free from slag or scoria.

"But further on this point. It is not the fact that sand is necessarily employed; but were it so, the proportion of alkali is so great that the slag formed would be, and is, perfectly liquid, and is not mixed in any sensible quantity with the mass of steel in the converter, upon which it floats, as I have already observed. Mr. Bessemer cannot but know that slag is found in his own converters, and is quite as, if not more, likely to contaminate his steel than the thin liquid slag produced in my process.

"I have now sufficiently shown that it is not the fact, as Mr. Bessemer states, 'that the metal solidifies while in a state of mechanical admixture with the sand and soda, and thus, instead of obtaining fluid cast steel by his process, Mr. Heaton obtains only a lump of spongy porous metal, intermixed throughout with slag and scoria.' Steel from my converters passed at once either into my patent reverberatory furnace, or into a furnace of Mr. Siemens, there kept in a molten state and thence run into ingots is as homogeneous, and to the full as good as Mr. Bessemer's. Mr. Bessemer knows that his own steel has been proved by Mr. Siemens to be greatly improved by being thus kept for some time in fusion after it has been poured out of his converter as Bessemer crude steel. It is, therefore, not a fact that my 'crude metal can be made into cast steel only by resorting to the old and costly Sheffield process of melting in crucibles, which melting process alone costs £5 to £6 per ton.' Here let me for one moment explain, for the question of cost is involved in this issue. Ordinary steel, such as is used, for instance, for rails, &c., is neither in my process, nor in Bessemer's, nor in Siemens', produced by crucible melting at all. Crucible melting is, and has always been, indispensable for manufacturing best tool steel. Bessemer himself, when he makes tool steel, has to employ crucibles. How can I characterize Mr. Bessemer's endeavour to hide this fact from the public and debit my process, specially, with the cost of £6 per ton, common to any process the object of which is the manufacture of best tool steel, while he is silent on the fact that he himself must pay it as well? Indeed, I cannot understand how Mr. Bessemer can compare his ingots for rails—which Grüner and other authorities say are not steel at all, but homogeneous iron—with my crucible tool steel which I am now selling at £50 per ton.

"Besides knowing that his own steel from the converter is not 'tool steel' until after it has been remelted in crucibles, Mr Bessemer is very well aware that Mr. Siemens has proved that with his furnaces adapted for crucibles cast steel can be melted therein at a cost of less than £1 per ton; and that in the Siemens reverberatory furnaces the cost of melting is scarcely half that. But, apart from such questions, I have but just turned out 40 tons of steel rails direct from my converter, without any remelting—rails of a fine fracture, neither 'fibrous' nor 'laminated,' but quite as homogeneous as Mr. Bessemer's, resisting the ordinary mechanical tests for steel rails, and produced at a cost with which no Bessemer steel can compete. Further such orders are in course of execution.

"The second point involves in its answer the to Mr. Bessemer unpleasant truth, that I can by my patent process make good steel, and far more cheaply than he can, out of pig irons such as those of Cleveland and Northampton that he can make no use of. This it is which is the strength of my patent; this is the reason why it is to be preferred to 'simply blowing cheap atmospheric air in numerous jets through the molten iron for 20 minutes'—a process which has been proved powerless to eliminate the sulphur and phosphorus which are found in the great majority of pig irons, and effectually debar them from the privilege of being converted into Bessemer steel.

"As bearing upon this convertibility of impure brands, it may be interesting to you, Sir, to learn, that half-inch bars of tool steel, made from Middlesborough No. 4 Clay-lane Forge Pig, bore, on being tested by Mr. Kirkaldy on Saturday last, a breaking strain which averaged upwards of 53 tons to the square inch.

"The third question is the paramount one of cost. I have already exposed the fallacy of Mr. Bessemer's statement of the cost of remelting. How little dependence can be placed upon the figures he has put forward can be inferred from his absolute silence on the waste in his process of pig iron, of which the trade is perfectly well aware, a waste materially increasing, in so far as his product is concerned, the price of the expensive raw material he employs, to say nothing of the enormous cost of his plant and the outlay necessary for its maintenance. With reference to the nitrate employed, it is quite true that in Dr. Millar's Preliminary Report 270 lbs. of nitrate per ton are stated to have been used; but the circumstances under which the experiments of Dr. Millar were carried on were purely exceptional, and the proportion of nitrate per ton usually employed is not, as Mr. Bessemer states, 270 lbs., at a cost of 36*s.*, but 224 lbs., at a cost of 28*s.* 6*d.*; taking the extraordinary high prices of nitrate that at present prevail. Ten per cent. of nitrate is all that I have found necessary for the production of a ton of steel from inferior brands, and considerably less than 10 per cent. for superior brands.

"That the references are erroneous which Mr. Bessemer appears to have drawn as to the cost of production of my steel and iron can readily be seen on reference to the certified cost-sheet.

"When I call to mind the fact that long since the date of my patents Mr. Bessemer has himself taken out three patents for the employment of nitrates, I am astonished he should advance such objections to the value and importance of the Heaton process. I can but say that the products of that process are being almost daily subjected to tests which can be freely witnessed by Mr. Bessemer at Mr. Kirkaldy's Testing Works at Southwark.

"Finally, in thanking you for the space afforded me, I will only beg permission to add that I trust it has now been proved that there have been no 'important misapprehensions prevalent with reference to the capabilities of my invention,' but that, on the contrary, your notice of my process on the 21st of October was correct in every particular.

"I am, Sir, your most obedient servant,

"John Heaton."

Note.—Since the above letters were in type a further letter from Mr. Bessemer has appeared in the *Times*, but as it contains no new facts, and is simply argumentative, we have not thought it of sufficient importance to justify us in reprinting it.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

December 1, 1868.—The Paper read was "Description of the River Witham and its Estuary, and of the various Works carried out in connection therewith, for the Drainage of the Fens, and the improvement of the Navigation," by Mr. W. H. Wheeler, M. Inst. C.E.

It was stated that the Witham was originally a tidal river, navigable by ships of considerable size as far as Lincoln, a distance of nearly 40 miles from the estuary. It was this portion of its course, from Lincoln to the outfall, flowing through a low fenny tract of land, and on which the skill of the engineer had been employed to make it subservient to the purposes of drainage, that formed the subject of this communication.

In the first part of the paper, the ancient history of the Witham, from the time of the Romans to the present day, was traced, and a description was given of the various works upon it. Evidence was adduced sufficient to prove, it was believed, that at one time the surface of the land near the estuary was considerably lower than at present, the level varying from 16 feet to 18 feet, at the mouth of the river, to 5 feet at a distance of 20 miles from the sea; that, while it was at this lower level, the land was inhabited and cultivated; that subsequently it was covered by the sea, and so remained for a number of years, during which time, by the natural action of the tides and upland waters, the soil was gradually raised to its present level; and that the stupendous embankments, by which this vast tract of country was protected from the sea, and on which its safety still depended, were the work of the Romans: for, as every ordinary spring tide must have daily flowed over the land, neither the towns of Boston, Spalding, or Wisbeach, which were inhabited by the Saxons, could have been built until the banks were erected. Until, however, about a century ago, notwithstanding all that had been done, the lower lands were still little better than a swamp. The works actually carried out for the recovery of the Lincolnshire Fens draining by the Witham, including the East, West, and Wildmore Fens, near Boston, and the Holland Fen, were next described. Thus, in regard to the Holland Fen, in 1767 the whole of the waters were brought to the original outfall at the Black Sluice, by a drain running through the centre of the Fen, its length being upwards of 20 miles, and its depth and width being sufficient to allow of the passage of boats. A sluice was erected at Boston, to exclude the tidal waters, and a lock was built for the purposes of navigation. The total quantity of land drained by this canal, and subject to taxation, was 64,395 acres; and, in addition, the drainage of about 30,000 acres, from the Glen and other sources, found its way to the sea by means of the South Forty-foot, as the drain was called. In the year 1846, the drainage being defective, the South Forty-foot drain was lowered from 4 feet to 5 feet, on an average, throughout its whole length, with a regular fall of 3 inches per mile. A new outfall sluice was built, having three openings of 20 feet each, one being arranged as a navigation lock, and the cill of the new sluice was laid 6 feet below the old one. The whole of this fen was now in the highest state of cultivation, and the value of the land, which before the drainage and inclosure was hardly worth five shillings an acre, had been increased upwards of six times.

In the year 1751, the decay of Boston haven was attributed to the diversion of waters from the Witham to other sources; thus, by the construction of the North Forty-foot drain, the waters which originally found their way into the Witham were discharged at the Black Sluice, situated below the town, while the West Fen waters were carried to their new outfall at Maud Foster Sluice, placed still lower down the haven. Under the provisions of an Act passed in 1762, a new cut was made, and a sluice erected a short distance above the town (called the Grand Sluice), consisting of four arches, each about 21 feet wide, three being appropriated to drainage, and the fourth being used as a navigation lock; self-acting sea doors were hung on the outer side of the sluice, and in the interior were 'slackers,' or draw doors, for regulating the height of the water in the river. A new cut or canal was also made for some distance up the river, taking a more direct course than the old channel, and the rest of the river up to Lincoln was widened and deepened. The cost of these improvements amounted to upwards of £60,000. It was then, and had ever since been, found in practice, that the drainage and navigation interests were hostile to each other. This was partly remedied by the construction, under an Act of 1812, of a new cut from Horsley Deeps (Bardney) to Washingborough, with lock-gates for the purposes of navigation, leaving the drainage water to find its way by the old course. Still, however, the navigation seriously interfered with the drainage. In 1864, on the recommendation of Mr. Hawkshaw (past President, Inst. C.E.), an Act was obtained, with powers to lower the river for a distance of 23 miles, from the Grand Sluice to Bardney Lock, to a uniform level of 1 foot below the cill of the Grand Sluice, equivalent to 5 feet below the existing cill of the Bardney Lock, and to widen the river to 50 feet at the bottom for about one half the same distance, gradually diminished to 36 feet at Bardney. This involved the lowering of the cills and chambers of four locks, and the consequent deepening of the canals in connection therewith. It was considered, that by lowering the bed of the upper part of the Witham, the height of the water on the cill of the Grand Sluice could be reduced from 9 feet to 4 feet; that the drainage of the district would be greatly improved; that the silt and other deposits in the haven would be kept lower; that the capacity of the river as a reservoir to receive the waters from the upper districts in times of flood would be considerably increased, the level of these floods being lowered by about 2 feet; and that many of the drains would be able to drain by gravitation, instead of requiring engine power.

The eastern and remaining portion of the Fens, termed the East, West, and Wildmore Fens, were the lowest in level of any in the district. These three Fens together contain about 40,000 acres of land. The late Mr. Rennie having been consulted as to the best mode of reclaiming and draining this large tract of land, advised that the upland should be separated from the lowland waters, and that for this purpose catchwater drains should be dug, skirting the whole district at the extremity of the Fens, and catching the water as it fell from the higher lands adjacent thereto. These catchwater drains were made to empty into the old Maud Foster drain, at a point about $2\frac{1}{2}$ miles above its outfall, and sluice doors were erected to prevent the upland waters backing into the fen drain. Maud Foster drain was widened and extended, and a complete system of internal drains was carried out in connection with it. The East Fen was drained by means of a new cut of about 14 miles in length, and a sluice for the discharge of the waters into the haven was built at Hob-hole, about 4 miles below Boston. Owing to the cultivation of the land, rendered possible by this thorough system of drainage, and other causes, further works became necessary; and under the direction of Mr. Hawkshaw, two centrifugal pumps, driven by two 90 horse-power engines, capable of lifting 700 tons of water per minute to a height of 5 feet, had recently been erected at Lade Bank by Messrs. Easton, Amos, and Anderson. A dam and lock gates being placed across Hob-hole drain, the water could now be lifted out of the upper part of the drain, so as at all times to keep it at a proper level below the surface of the lands in the East Fen.

By means of the several works executed for the drainage of these fens into the haven, the waters were discharged at various points from 680,392 acres, being the drainage area of the river Witham.

The present state and condition of the haven, as affecting the drainage and the navigation, and the causes which had conduced to its decay, were next considered, and the means proposed and adopted for its improvement were then described.

The basin or estuary, called the Wash, which received the waters of the Witham, the Welland, the Nene, and the Ouze, was about 300 square miles in extent. It was shallow and full of shifting sands, which were gradually but surely extending and gaining on the sea. The waters discharged from the rivers in times of flood held in suspension large quantities of mud, and meeting with an opposing tidal current, highly charged with silt, a deposit took place, which the back waters were not strong enough entirely to remove. This silting up of the estuary might be further traced to the embanking and inclosing of the lands, the erection of sluices preventing the free flow of the water; the improved drainage of the land by means of tiles; and the use of steam power for effecting the more rapid discharge of the waters. Sluices were constructed for, among other things, purposes of navigation. Now it was difficult to combine effectively both the drainage and navigation interests; but, by deepening the channel, it was believed that vessels might pass up with the flowing tide, and return with the ebb. Where the tidal streams could not be made available, it was advisable that there should be separate cuts for the navigation alone. In the author's opinion, the erection of a sluice across a tidal stream assisted the deposits of silt and mud, instead of preventing it, as was sometimes supposed. The stagnation produced by the sluice also caused the mud to accumulate in the channel against the doors, and so stopped the egress of the waters through the sluice. This had been the case at the Grand Sluice in the Witham at Boston; and the bed of the river had been raised in proportion, interfering to a considerable extent with the navigation. The erection of the Grand Sluice had been condemned by engineers at the time, and modern engineers took the same view. Mr. Hawkshaw in the year 1861, and again in 1864, had recommended, with other works, the removal of this sluice.

The author, in a brief recapitulation of his remarks on this branch of the subject stated, that all rivers carried with them in their flow large quantities of soil; that wherever the flow was impeded, the soil was deposited on the bottom of the river or estuary; that the tides, meeting the freshes, caused a deposit to take place, and where the back water was not sufficient to wash this away, an accumulation of mud and sand occurred, choking up the outlet and raising the bed of the river; that before Art was brought to bear on the Fens in their natural state, the waters flowing over the low lands, formed huge reservoirs, which on the return of the tide made the freshes sufficiently powerful to carry out to sea the sand and mud deposited, and to keep the rivers scoured out to their proper depth; that by embanking these lands, and confining the waters to defined channels, the tides became stronger than the freshes, and sand and mud were deposited at the mouths of rivers, hindering their discharge; that, further, by the improved drainage causing the rapid discharge of the waters, the freshes were sudden and impetuous, instead of constant and gradual, allowing the deposit brought down by them to be washed back by the tides, and deposited on the beds of rivers, and that this took place to so great an extent as materially to raise the level at the outlet and interfere with the drainage, and that the more the operations of Nature were interfered with the greater was this effect; that wherever sluices or weirs were erected across a tidal river, by causing a longer period of stagnation at the point where the sluice was erected, and preventing the scour of the returning ebbs, a large deposit took place, requiring the whole strength of the winter floods to effect its removal.

The channel for vessels coming to Boston up the Witham was both tortuous and difficult, owing to the numerous shoals and shifting beds of sand. The foreshore of the coast at the point where the Witham debouched was a hard, stiff clay, and known by the name of the "Scalp." Along this the water flowed in a south-easterly direction for some distance, and then turned suddenly in a north-easterly direction, the Scalp forming a long elbow round which the waters had to find their course. At this elbow the river Welland joined the Witham, almost at right angles, and both flowed together in one channel for about 4 miles, when the united streams again divided into two. The greatest hindrance to the discharge of the waters occurred at this elbow, where the Witham and the Welland spread themselves over a wide and unconfined space, and so lost their velocity, and with it the power to move the sands and mud accumulated during the summer months. Owing also to the long winding course of the Witham round Elbow Point, a distance of 4 miles (the direct course across this clay foreshore being only $2\frac{1}{4}$ miles), there was a great loss of fall. Thus, while at Hob-hole Sluice, about 3 miles above the bar, there was 7 feet of water at low water, and in Clayhole, about 1 mile below Elbow Point, it was 10 feet, at the bar there was not more than 10 inches. The removal of this bar, and obtaining a greater fall, had been the aim of all the engineers who for the last one hundred and twenty years had reported upon the haven. One course had been invariably recommended—the making of a new cut through the clay foreshore, about $1\frac{1}{4}$ mile in length, confining the water to this channel, and training the Welland with fascine work through the shifting sands to a junction with the Witham in Clayhole. The course of the Witham would thus be shortened about $1\frac{3}{4}$ mile, and being confined by the embankments and fascine work, would not have such a great body of shifting sand to contend with, and would be at once carried to deep water in Clayhole. This would allow all the flood waters from the several sluices to be properly discharged, and give a general relief to the low lands of the Fens. It had been estimated that the total expense for the Witham Channel would be about £60,000, and for the Welland Channel about £20,000. By carrying out this plan, many acres of land, at present covered by the tide, would in course of time be warped up and become good marsh land.

Reference was then made to the works carried out in the year 1825, under the advice of Sir John Rennie (past President Inst. C.E.), at a cost of about £40,000, by which the channel between Skirbeck Church and Hob-hole Sluice had been straightened, and the course of the river had been contracted. Thirty years after the commencement of this work, 300 acres of the reclaimed land had been sold for £10,000, and been embanked by the purchaser; while a few years ago, two other marshes had been embanked by the commissioners, and had been let on lease at a rental of £310 per annum, the area, including foreshore and bank, being about 160 acres.

The system of parallel training walls, constructed of faggots, clay, and chalk, had been adopted to a great extent for the Fen rivers, and had been found to answer better than any other plan. The manner in which these training walls had been carried out, on the rivers Welland and Witham, was then described.

In conclusion, the general results of the inclosure of the Fens were briefly reviewed; and it was observed, that the appearance and prosperity of this large tract of land, equal in extent to many counties, when contrasted with what it was a century ago, was a striking proof of the ingenuity and industry of man, and reflected the highest credit on the skill of the engineer and the enterprise of the people.

At the Monthly Ballot, the following Candidates were balloted for and duly elected: as Members—C. G. Blatchley, G. Broadrick, T. F. Brown, A. Cato, J. H. Hartwright, J. W. James, A. Roberts, R. Roberts, R. Watson, and G. Woodbridge; as Associates—S. P. Bidder, jun., R. S. Brundell, F. C. Bullmore, T. P. Campbell, E. S. Currey, J. G. V. Dantas, F. G. Davis, Captain W. M. Ducat, R.E., J. S. Farmer, H. A. Fisher, T. P. Gaskell, G. Harrison, J. T. Holgate, E. Lane, H. C. D. La Touche, E. A. Sacré, J. N. Smith, E. J. Statham, T. S. Tancred, H. A. Vivian, and W. Webster.

A Report was brought up from the Council stating that, under the provisions of Section VI. of the Bye-Laws, the following Candidates had been admitted Students of the Institution since the date of the last announcement:—R. Harrison, K. W. Hedges, F. de S. T. Homem, J. P. Maxwell, W. H. Read, and C. R. Western.

December 15, 1868.—The paper read was "On Machines employed in Working and Breaking down Coal, so as to avoid the Use of Gunpowder," by Mr. S. P. Bidder, jun., Assoc. Inst. C.E.

It was stated that the object of this communication was to direct attention to the 'winning' of coal by mechanical appliances, with the view of obviating the loss in production and the danger to the colliers which were incidental to the use of gunpowder. Several inventions for this purpose were described, including the machines of Mr. Cochrane, Mr. Chubb, Mr. Grafton Jones, and Mr. Farum; and it was remarked that the great defect in all these machines was their limited expansive power, which did not exceed 3 inches, and which in practice proved to be insufficient for breaking down a mass of coal in a workable state. Machines for cutting grooves or slots in the coal had also been tried, but it was said only with partial success.

After fully considering these various systems, the author had, in conjunction with Mr. John Jones, devised a machine which had been submitted to actual trial on a working scale at the Harecastle Colliery, where the results were so satisfactory as to induce the proprietors to make arrangements for its immediate adoption. The machine consisted of a small hydraulic press of 12 tons power, to which was attached a pair of tension bars, bent in the form of a connecting rod or hinge strap. These were placed one over the other in the bore-hole, and between them, at the extreme end, there were a clearance box and two metal pressing blocks. between which was forced, by the action of the hydraulic press, a split wedge 15 inches long, causing a lateral expansion of 3 inches. The ram was then withdrawn, and a second wedge was inserted between the two parts of the first wedge, and was forced up until sufficient expansion was obtained to break the coal. The operation could be repeated several times if found necessary. The whole apparatus would weigh about 50 lbs. The hydraulic press was in future to be made of steel, and the ram would be cored out. In practical working, each gang of colliers would be provided with the tension bars and three wedges, while the presses would be under the charge of the men who at present occupied the position of firemen, so that no new class of labour would be introduced, while the risk of firing would be got rid of. Trials had been made both in the 7-feet and the 9-feet seams at Harecastle; and in the latter, with three wedges, about 12 tons of coal had been brought down in only three or four pieces. It was found that the press could be applied and the blocks brought down in less time than was consumed by firing and waiting for the smoke clearing.

Explosions in mines were known to arise, very frequently, from the employment of gunpowder for blasting. In the interests of humanity alone an efficient substitute had long been desired by practical men; and this, it was believed, had been accomplished by the machine under consideration, which had also the advantage of preventing the waste of coal incurred by the present system.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

THE CORROSION OF IRON STRUCTURES.

By William J. M'Alpine, C.E.

Formerly it was assumed that iron was subject to a rapid corrosion when immersed in water, or exposed to the alternations of the water and the atmosphere, and the every-day experience of constructors seemed to confirm this opinion. Wrought-iron bolts in wooden dams, and similar places, and in works wholly under water, frequently rapidly oxidize. Cast-iron water-pipes in city streets are frequently found greatly corroded; and cannon shot, immersed in sea water for half a century, and sometimes less, have been found with the mass of the metal entirely changed from iron into plumbago, or deeply pitted by oxidation.

During the earlier discussions of the subject the inquirer was frequently staggered in his belief in the generally received opinions by finding both wrought and cast iron which had been immersed many years but slightly oxidized, and wholly unchanged in its structure.

The cannon of the *Royal George*, which had been submerged half a century, when first taken out, were so soft that the metal could be cut with a knife, but immediately hardened on exposure to the air, and were again fired. Some muskets and cannon, sunk in lakes Erie and Ontario during the war of 1812, were, forty years afterwards, found to be but slightly rusted.

An iron steamer, the *Aaron Manby*, which was launched in 1822, and kept in constant use for twenty years, was carefully examined, and no signs of corrosion found; and, ten years later, it is stated that she had required but small repairs for the whole period.

William Fairbairn also cites many cases where iron ships, which had been ten or fifteen years in salt water, showed no corrosion. This subject was much discussed in England in 1850, and the unexpected absence of corrosion in wrought-iron ships, even on the interior surfaces and iron parts, was then attributed to the vibration of the metal, as was noticed on comparing the amount of the corrosion of railway bars in the track with those laid outside of it.

Plumbago was obtained from cast iron immersed in acidulated water in 1822; and, forty years later, Dr. Calvert produced the same result by placing it in sea and foul water.

A dozen years earlier Mr. Mallet reported his well-known experiments on the corrosion of different kinds of iron in pure and foul atmospheres, and in clear, foul, acidulated, and salt waters, and arrived at the following conclusions:—

That iron exposed to water holding air in combination corrodes on the surface, either uniformly or in places, by rust or by the conversion of the iron into plumbago; and that corrosion depends upon the want of homogeneousness of the surface, or in its density or hardness, or in the combination of the carbon with the iron.

This subject was very thoroughly discussed by some of the most eminent engineers of London in 1862, and numerous cases were cited both of corrosion and its absence in iron under water, and the cause explained.

The examples then stated, and numerous others, showed that cast iron of a particular description corroded rapidly, or changed its structure by a few years' immersion in foul or salt water, while other irons were entirely unaffected when exposed in the same way for twenty, thirty, and forty years. In the same structure, as in the case of the iron gates of the Sheerness dock, three pairs of gates had resisted the action of salt water for forty years, and a portion of the fourth pair, put in several years later, had been much softened and injured by its exposure.

Several of the leading engineers instanced numerous cases of square cast-iron piles, standing partly in and partly out of salt water, and a portion alternately wet and dry at each tide, which, after periods of eighteen, twenty-four, and thirty-one years, and intermediate periods, showed no signs whatever of corrosion or change; "the square angles of the iron were as sharp as when they left the foundry."

Mr. Simpson, the past president, said that in his practice he used great care in the selection of the iron, and such iron was practically incorrosive. The members stated that wherever this corrosion or decomposition had occurred it was wholly due to the quality of the iron. The engineer has, therefore, only to select that of a proper quality to insure durability. My own experience and examinations, so far as they reach, confirm these opinions.

Cast iron, to resist corrosion to its greatest extent, should be as hard as the case will admit, of an even, close grain, and with the carbon combined, and not in the form of graphite. Impure soft foundry iron will corrode rapidly; close-grained gray iron, of an even texture, will resist corrosion in the most exposed places without sensible injury; and white iron of good quality may, for all practical purposes, be considered as imperishable in such situations. Care should also be taken not to place iron in contact with other metals, so as to produce galvanic action.

It is well-known that many cast-iron water mains have corroded greatly, not only externally, but internally. In the latter case the oxidation sometimes takes the tubercular form, where the rust is collected and aggregated in hard knobs.

In the early manufacture of water pipes they were often made from the worst quality of metal; it could hardly be called iron, but was a composition of cinders, sand, scoria, and iron of the softest kind, loose grained, and in large crystals; indeed, precisely such a mixture as would offer the least resistance to corrosion.

Water pipes, placed in the streets of the city in earth alternately wet and dry, and saturated with mephitic gases from sewers and gas pipes, are exposed to corrosion more than under almost any other circumstances, and if made of the material just stated will be destroyed, where those of a proper quality of metal would endure a very long time. The internal corrosion, however, where the iron is exposed only to the action of pure water and a small amount of air in combination, will not occur to any appreciable degree if the iron is of the proper quality.

The strength of cast-iron pipes of the usual thickness is so far beyond the pressure of the water and occasional percussions, that the manufacturers seem to think that the weakest metal will answer; and the engineers have not yet, in their specifications and inspections, required enough care in the selection of the metal best calculated to withstand corrosion.

THE LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The usual monthly meeting took place on Saturday the 5th ultimo. It was very numerously attended, and the chair was occupied by Mr. J. Newton, of the Royal Mint, president. The first business of the evening consisted in the election, as honorary members, of Messrs. A. M'Gillivray and A. Anderson, and this was followed by a discussion as to the time, place, and general arrangements for celebrating the seventeenth anniversary of the formation of the institution. Finally it was determined that this should take the form of a banquet to be conducted on a scale similar to that of February last, and which had given great satisfaction. The time named for the celebration was the middle of February next. Mr James Irvine, of Messrs. Simpson's Engine-works, Pimlico, then proceeded to read a paper "On Rock-Boring Machinery."

After some general remarks as to the desirability of having an unbroken succession of monthly papers for the ensuing year, the author addressed himself to his subject. He described the various appliances which had been contrived in time past for penetrating rocks by mechanical means, and showed wherein they had generally failed. By this course Mr. Irvine enabled his audience to institute comparisons, and comprehend more clearly his explanation of a rock-boring engine, now at work in Cornwall, and which was, he said, in every way successful. This latter was known as Doering's patent. It is scarcely necessary here to follow the author of the paper in his preliminary statements, and we shall only, therefore, reproduce some of the main points of the concluding portion of the paper of Saturday. "Mr. Doering's rock-boring engine," said Mr. Irvine, "consists of a gun-metal cylinder bored out to a diameter of $2\frac{3}{4}$ inches, or an area of about 6 inches, and fitted with a steel piston. It is worked by compressed air at a pressure of from 25 lbs. to 30 lbs. per square inch; thus $30 \times 6 = 180$ lbs., which is the pressure or blow administered to the drill at every stroke of the engine, the speed of the latter being 300 strokes per minute. The piston and rod are forged in one piece, the rod being hollow and pierced with a number of holes, at proper intervals, and for a purpose to be explained hereafter. To the outer end of the piston rod the boring drill is attached and fastened by an ordinary key, with a movable nut, which permits of readjustments when the constant hammering loosens the drill. The packing throughout the engine consists of metallic rings, which answer well, and minimise friction. The piston differs but slightly from that well known as Ramsbottom's, and is worked to and fro by compressed air admitted to the cylinder by aid of a circular slide valve of peculiar construction, and which is a model of simplicity. The valve itself gains alternate motion by the action of compressed air—(The movement was made clear by diagrams). In the centre of the piston rod is a square hole, into which is fitted a $\frac{3}{4}$-inch steel bar, on the end of which is a ratchet wheel with twenty-four teeth. Beside the main cylinder is a small one with a piston, to which is attached a pawl, which falls into the ratchet. When the main piston has passed a certain point in its travel, the air rushes through a hole from the large into the small cylinder and drives its piston forward. This acts upon the pawl and ratchet, and causes the latter to move to the extent of one tooth; the effect is to give the drill a partial turn at each stroke, and an entire revolution at the end of twenty-four strokes. The air from the small cylinder escapes through the hollow piston rod into the atmosphere.

The method of "feeding" the drill forward into the rock is ingenious yet simple, and accommodates itself self-actingly to the hardness, or otherwise, of the rock to be bored. (This was satisfactorily demonstrated by diagrams on Saturday, but can hardly be made intelligible without them.) The stand for supporting the apparatus, and allowing it to move laterally or vertically, is portable, and easy of attachment by pressure of air at any spot, on the principle of the sucker, or the pneumatic hat peg. Ball and socket joints on the arm of the stand allow a universal movement of the apparatus it supports, . . . the air-pumps for compressing the air are three in number, and worked by a three-throw crank, driven by a small steam-engine. The pumps are immersed in water to keep them cool.

Many more details were furnished by the author of the paper, as well as particulars of the work effected by engines of the kind in various mines of Cornwall, but it is not possible for us at present to give them place. The great merits of the contrivance appear to us to be its adaptability for its purpose, its simplicity, economy of action, and automatic character.

A practical discussion followed Mr. Irvine's paper, and this was shared in by Messrs. Edmonds, Keyte, Dewar, Walker, Stokoe, Gibbon, Bunt, the chairman, and others. The sitting terminated with a vote of thanks to the author; and we have rarely attended a more satisfactory meeting of the Associated Foremen Engineers of London.

PHILOSOPHICAL SOCIETY OF GLASGOW.

ON THE RECOVERY OF SULPHUR FROM ALKALI WASTE.

By Mr. Ludwig Mond.

Attempting to give you a short description of my process for the recovery of sulphur from alkali waste, I beg, in the first place, to ask your pardon for calling your attention to a simple manufacturing process of so little general interest on the first meeting of this assembly, which might certainly have been occupied by a worthier subject: and still more for my boldness in addressing you in your own language, which I have by no means sufficiently at my command. I will, however, do my best to bring before you, as briefly as possible, the few points of interest which my subject may offer, and hope you will be kind enough to excuse the many deficiencies which I am unable to escape.

It will be unnecessary for me to explain to an assembly of Glasgow gentlemen the vast importance of the alkali trade, you having within your walls, at St. Rollox, the most important and most interesting alkali works in the world—the most important and most interesting, not only on account of their vastness, but because a considerable number of the most valuable improvements in the manufacture of alkali and its branch industries have originated or been first adopted in these works, several of which are still the property of the firm, and carried out at their premises only.

The process for the manufacture of bleaching powder, which has now become so extensive that it can hardly be called a secondary product, was invented by the founder of the firm, and is still carried out in their works on a scale at least double that of any other works in the world. The production of chlorine from nitrate of soda, and the recovery of manganese, are inventions of their late manager, Mr. Dunlop, and are still specialties of the St. Rollox works; and among other improvements which have been first introduced here, I may name specially the apparatus for the methodical lixiviation of black ash, of which I shall have to treat more fully this evening, as it was on this invention that the final success of my process altogether depended; and it is certainly remarkable that the first apparatus ever used for the lixiviation of black ash is at present employed in the recovery of sulphur by my process. Yet many of you will be astonished at the enormous development of the alkali trade within the last few years.

In 1864 the quantity of salt decomposed in Great Britain amounted to 288,000 tons, and within three years it has risen to fully 400,000 tons per annum, or nearly 40 per cent. The transformation of this quantity of salt into sulphate of soda requires about 320,000 tons of oil of vitriol, which contain nearly 100,000 tons of sulphur. This large quantity of vitriol is at present almost entirely obtained by burning iron and copper pyrites, containing from 36 to 50 per cent. of sulphur. Thanks to the exertions of Messrs. Charles Tennant and Co., who have been the principal promoters of a company formed for the purpose of purchasing, and connecting by railway with the sea, the Tharsis mine, near Huelva, one of the richest mines in Spain (which promises to furnish the total supply of pyrites to Great Britain for any length of time); and also owing to the intelligence and perseverance of another of your fellow-citizens, Mr. William Henderson (who has brought his process for the extraction of copper from these ores, after the sulphur has been burnt off, to such an unprecedented pitch of perfection)—the sulphur in these ores is now supplied at a price which places England in as favourable a position as any other country in respect to this important raw material, and which makes the use of native sulphur in the manufacture of salt cake almost impossible. Although the large quantity formerly used for this purpose has within the last twenty years been almost altogether replaced by pyrites, the export of brimstone from Sicily, whence hitherto has come all the supply of this valuable material, has been continually rising, and has now reached over 200,000 tons per annum, about 50,000 tons of which are consumed in Great Britain.

This shows that brimstone has found other fields of employment, even more readily than it has lost its former place; and we see here again, that in our time of rapid progress, new raw materials, or new processes, will generally make their way, and give beneficial results, without doing any harm to the trades which they have been originally intended to supplant.

Besides the manufacture of pure sulphuric acid, which we are still unable to obtain from pyrites by a really practical method, and some other industries of minor importance, the largest quantities of brimstone are now converted into rolls and flowers of sulphur, used in vineyards and hop-gardens for suppressing the much dreaded diseases of those plants, and in the manufacture of gunpowder, the consumption of which must certainly have reached very large proportions, since all nations have exerted their best energies to find out the most effectual method of using this substance for their mutual destruction. The indispensability of sulphur in the manufacture of gunpowder, even makes it a question of political importance for any nation not to be altogether dependent on another country for the supply of a material so necessary for the defence of its freedom and independence; and this question has certainly become more grave since Italy has been formed into a strong and united kingdom. The appearance of a few English men-of-war would now-a-days hardly be sufficient to re-open the ports of Sicily for the exportation of brimstone, as it has been on a former occasion. I hope to be able to show you that the repetition of such a scene will no longer be necessary, and that England is now able to obtain the brimstone which she imports from a material which has hitherto been worse than valueless, being only a source of inconvenience and outlay to the manufacturers, who could not help producing it; and that this brimstone can be produced at a cheaper rate even than at the mines in Sicily.

Ever since the illustrious Leblanc, more than eighty years ago, introduced his famous process for the manufacture of alkali from common salt, which (excepting only a few hundred tons made from cryolite) still furnishes all the vast amount of alkali at present used, and which in all probability will continue to do so for many years more, it has been known to chemists and manufacturers that nearly all the sulphur used in this manufacture remained in the insoluble residue which is left after having separated the alkali by lixiviation from the crude soda, or black ash, obtained by melting sulphate of soda with limestone and coal.

This residue, well known under the names of alkali waste, blue waste, or tank waste, is produced in very large quantities, 1½ tons of dry, or above 2 tons of wet, waste being formed for every ton of alkali manufactured. It accumulates in the vicinity of alkali works in heaps and hills of sometimes enormous size, which create a considerable nuisance, by exhaling in damp weather volumes of sulphuretted hydrogen, the disagreeable qualities of which need no comment, and by giving rise to the formation of yellow liquors washed out by rain, and containing sulphides of calcium, which have a very deleterious effect on wells and rivers to which they gain access. A large number of distinguished scientific and practical men have, for the last thirty years, spent much time and labour in the task of recovering the sulphur thrown away in the waste (which now amounts, as already stated, to nearly 100,000 tons a year in Great Britain alone, and represents a considerable value), and doing away by this means with the nuisance referred to, at the same time.

Before all others, it is Mr. William Gossage to whose ardent labours we owe so many valuable improvements in the manufacture of alkali, who will always be named in connection with this subject for the brilliancy of his ideas, and his perseverance in carrying them out. Though unsuccessful, like most others, he cleared the way for future investigations; and I gladly state that I derived much benefit from conversations with him whilst I worked out the details of my present process.

The problem of obtaining sulphur from the waste was a comparatively simple one. The great difficulty, however, was to treat the large bulk of waste without incurring too much expense for plant and wages. The wet waste containing no more than 12 per cent. of sulphur, which has an average value of say £6 per ton, it will be obvious that only a very simple method, which requires small outlay to start with, and but little expenditure for repairs and labour, would satisfy the primary condition of a manufacturing process—viz., to pay well for the invested capital. I believe I have ultimately overcome these difficulties completely. The waste is treated by my process without being removed at all, and the wages are thus cut down to a very low amount.

The total outlay for plant is generally covered by the savings of one year, and the maintenance of the apparatus is very trifling. These are the practical points of the process which have made it successful, where so many others, working in the same direction, have failed, and where, consequently, the merits of the process in comparison with others must be principally looked for.

My process is based on the following principles:—The conversion of the insoluble compound of sulphur and calcium in the waste into soluble compounds by oxidation, the separation of these soluble compounds by lixiviation, and the ultimate recovery of the sulphur from the solutions thus obtained by muriatic acid.

When I started my researches in connection with this process in 1860, I was not aware that these reactions had been formerly proposed for the same purpose. A few years ago, however, I found that they had already been laid down, before I was born, in the specification of a patent of Mr. W. H. Leighton, in October, 1836. This interesting document, entitled "Improvements in converting Sulphate of Soda into Subcarbonate of Soda," relates principally to a very impractical construction of a black-ash furnace, with a perforated floor through which steam should be introduced. At the end of his paper the author states—"I allow the waste to remain in the vats until it heats and gives off smoke. I then lixiviate it, and obtain liquors from which I separate sulphur by muriatic acid." It is, however, very improbable that he has ever worked out this part of his specification, as no account of it is to be found except in the register of patents, and as it escaped the notice of all other investigators of the subject. Though nearer to my method than any later suggestion, it was quite impracticable, as it would have required a very long time and an enormous plant, owing to the oxidation proceeding very slowly and not being at all under control, and would have given very small returns. From the date of this patent to the time of the starting of my researches, only one process has been published for utilizing the products of oxidation of alkali waste.

This relates, however, solely to the manufacture of hyposulphite of soda, and was patented by Mr. W. S. Losh in 1852. He oxidized the waste in heaps, lixiviated, mixed the liquors obtained with a solution of carbonate of soda, settled and boiled the cleared liquors down to crystallization.

This process has ever since been worked very successfully at the Walker Alkali Works, near Newcastle, with which Mr. Losh has been connected, and he was certainly the first who oxidized waste on a large scale in order to utilize it. By his mode of oxidation, as Mr. Clapham, the present manager of the said works has kindly informed me, about one-fifth of the sulphur contained in the waste is obtained in solution—a quantity altogether insufficient to make it available for sulphur recovery; and this may probably have been the reason why Mr. Losh never thought, or certainly never mentioned, that his liquors might be employed for this purpose.

During the time that I was carrying on my investigations, and before they were brought to a close, no less than three patents have been taken out on the same subject; the first of which was granted to two well-known fellow-citizens of yours Mr. J. Townsend and Mr. James Walker, and is dated 11th December, 1860. These gentlemen, after having oxidized and lixiviated the waste in exactly the same, way as Mr. Losh, proceeded to convert all the sulphur in the liquors thus obtained into hyposulphite, by exposing them to the action of air in towers or otherwise, and then mixing them with the cheaper sulphate of soda instead of carbonate of soda; thus producing at the same time sulphate of lime, containing a little hyposulphite, which they propose to sell to papermakers under the name of precipitated antichlore. Further, they suggest mixing the liquors obtained from the waste with the liquors obtained in making chlorine from manganese and muriatic acid, and separating by these means sulphur more or less mixed with sulphide of iron and sulphide of manganese, according to the proportions used. This last suggestion, and the use of sulphate of soda in place of carbonate of soda in the manufacture of hyposulphites, were valuable points in this patent. They, however, as well as the two other patentees referred to, Mr. A. Noble and Mr. J. L. Tullion, whose specifications contain nothing new worth mentioning, have to all appearance given most of their attention to the production of hyposulphites, and have never taken up the question of sulphur recovery in earnest. All three oxidize and lixiviate the waste only once, according to the method of Messrs. Leighton and Losh, and consequently their processes would not yield any more sulphur than former ones, a quantity so small that it would never have repaid the cost of erecting plant, and which certainly did not deserve the name of sulphur recovery.

If any of them had worked at the matter at all, he could not have failed to make the same observations to which I was led by my first experiments.

In studying the conditions under which the largest possible amount of soluble sulphur compounds could be obtained by the oxidation of waste, I very soon found that these compounds only increased up to a certain point, and would slowly decrease on continuing the exposure to air any longer.

When, however, the soluble compounds at their highest points were removed by lixiviation, the waste would yield, by a second oxidation, the same quantity as before, and even a third repetition of this treatment would give nearly as good results. Thus, by oxidizing and lixiviating the waste three times, I was able to extract from the waste three-fifths of the sulphur which it contained, the remaining sulphur being nearly all in the form of sulphate and sulphite of lime, both insoluble; but which, far from being noxious, made the waste a valuable manure, owing to its containing, besides the gypsum, very large quantities of carbonate of lime and caustic lime, as well as soluble silica and a little soda. These experiments were carried out at an old-established alkali work at Ringkuhl, near Capel, in Germany. At the time named, the black ash was lixiviated there by an old method, which has since been abandoned, according to which it was several times removed from one vessel to another. This caused the waste to be so very dense, that all my efforts to oxidize it in heaps, as by forcing air through it, failed completely, so that I could only obtain the results mentioned by exposing it to the air in shallow layers on shelves.

Having never had to deal with other alkali waste, I naturally concluded that the same would be the case with the waste of other works, and took out patents for this mode of working in 1861 and 1862, after having successfuly treated considerable quantities of waste in the works named.

Coming to England in 1862, I was soon convinced that this process was quite impracticable for the treatment of the vast quantities of waste there produced, and would be fearfully expensive at the rate of wages there current, which was fully three times as high as in the works I came from. I also noticed the vast difference in the condition of the waste produced by the excellent mode of lixiviation already noticed, according to which mode the waste remains, so to say, suspended in liquor and water until it is spent, and is thus left very porous. As soon as I found an opportunity, I tried again to oxidize it by forcing air through the waste, and this time I succeeded so well that the time of oxidation, which was previously fourteen days, was reduced to as many hours, so that there was now a possibility of treating the waste in the same vessel in which it was made, without increasing the plant to an unreasonable size, and thus altogether avoiding the labour for transporting and manipulating the large mass of material, which has always been the greatest difficulty of the question. Having fully satisfied myself about the practicability of this method, by experimenting with vessels holding 10 tons of waste, I took out a patent for it, dated the 8th September, 1863, since when the process has undergone no change in its essential features.

The apparatus for the lixiviation of black ash, so often referred to, consists of a set of four to six vessels, mostly called vats, which stand on a level, and are connected by pipes in such a way that the water entering one vat will pass from the bottom of it to the top of the next, and so on. They are fitted, besides, with taps and shutes to convey the strong solution of alkali to settlers. By this arrangement the water always comes in contact with black ash very nearly spent, and the weak solution obtained from this is made to pass through black ash containing more and more alkali, until at the end they meet fresh black ash, and consequently become strongly concentrated. At the same time, the black ash remains continually covered or, so to say, suspended in liquors of different strengths, and the waste is thus obtained very porous. Formerly this waste was cast out of the vats as soon as the alkali was washed out, and the vats were then refilled with black ash. I, however, proceed to oxidize and lixiviate the waste in the same vats, so that it is not removed until the obtainable sulphur as well as the alkali are washed out. As a matter of course, I want for this purpose an additional number of vats, which, however, amounts to six extra vats only for every set of four as generally in use Thus a set of ten vats is formed, which are all connected in the usual way, but are provided in addition with extra pipes, taps, and shutes, for the passage of the liquors obtained by lixiviating the oxidized waste, and which we will call sulphur liquors, through the several vats in order to obtain them more concentrated, and finally into reservoirs or cisterns. All the vats have also perforated false bottoms, the space underneath which is connected with a fan by means of pipes with dampers, which latter allow of the regulation of the oxidation.

As soon as the alkali is completely washed out of the waste, and the last weak alkali's liquor is drained off, the damper in the windpipe is withdrawn, and air forced through the waste for a certain time, which varies according to the pressure of the blast, the porosity of the waste, and the desired composition of the liquors to be made.

The exact time of exposure and pressure of blast which will yield the best results must be ascertained by experiments for almost every work separately; generally an exposure of 12 to 16 hours, and a pressure of 3 to 4 inches of water, being sufficient.

On the admission of air the waste soon begins to heat, the temperature rising gradually to 200° Fahr. It gives off quantities of steam, turns quite greenish, but of a bright yellow colour on the top, then becomes more and more dry, and would finally take fire if the blowing was continued sufficiently long.

When the proper state of oxidation is arrived at, which the workmen will soon know by experience, and see pretty well from the appearance of the waste, the blast is stopped, and the soluble products are washed out with water. This operation can be readily performed in six hours. The blast is then again turned on for the same length of time as before, and the waste lixiviated, and the same treatment repeated a third time.

As you see, from the numbers already given, this treatment altogether requires from 60 to 72 hours only. The sulphur liquors are allowed to pass several vats filled with oxidized waste, by the connecting pipes already alluded to, and are thus obtained concentrated.

They contain from 5 to 7 per cent. of sulphur, principally in the form of sulphides and hyposulphites. The separation of the sulphur from these liquors by means of muriatic acid, which appears to be so very simple, was attended with a good deal of quite unexpected difficulty. During the first year of working the process, I carried the oxidation of the waste so far as to obtain liquors containing principally hyposulphite and only little sulphides. These latter I converted into hyposulphite by passing sulphurous acid through the liquor, and then added muriatic acid, and boiled in order to obtain from the hyposulphite sulphur and sulphurous acid. The latter was utilized for converting the sulphides of another portion of liquor into hyposulphite.

I obtained, however, a very impure sulphur, containing so much gypsum that it could hardly be melted, and I found it very difficult to obtain sulphurous acid in sufficient quantity for the first part of the process, though the original liquor contained only one-fourth of the sulphur in form of sulphides. These inconveniences, and the considerable loss of sulphur in form of gypsum, induced me to abandon this method and to adopt the following:—

The oxidation of the waste is so regulated that the liquors obtained contain just sufficient oxygen, in the form of hyposulphurous acid, to oxidize the calcium and hydrogen present, in the form of sulphide of calcium and sulphydrate of calcium, into oxide of calcium and water. These liquors are run into vessels of wood, brick, or stone, simultaneously with an equivalent quantity of muriatic acid, the liquid in these vessels being kept continually at a temperature of 140° to 150° Fahr. The exact proportion of liquor and acid, which may of course be precisely ascertained by analysis, can be sufficiently well judged, from the colour of the mixing liquids, by an experienced workman. I will try whether I am able to show you these colours, and to separate some sulphur from the liquid in this bottle, which is of the composition above referred to, though it is very difficult to manage a process of this sort on a small scale. By this mode of working, about 90 per cent. of the sulphur contained in this liquor is precipitated in a very pure state.

It settles very quickly, the clear supernatant solution is run off, and the sulphur drawn out by a door at the bottom of the precipitating vessel, into a wooden vat with double floor, where the remaining chloride of calcium is thoroughly washed out with water. It is then dried, and melted by heating it in an iron pot, and is thus obtained in the lumps which are before you on the table, and in a purer state than the average brimstone imported from Sicily.

As you will see from the different numbers above mentioned, fully one-half of the sulphur contained in the waste is thus obtained in a very pure and marketable form; and the alkali waste yearly produced in Great Britain could furnish nearly the full quantity of brimstone which is now imported, without falling back on the tremendous quantities of waste stored up in the vicinity of old works.

(*To be continued.*)

MONTHLY NOTES.

An Inter-Oceanic Canal.—A company has been lately formed in New York for the construction of a ship canal across the Isthmus of Darien, to connect the Atlantic and Pacific oceans. As the sum thought to be sufficient for its construction, 100,000,000 dols., has been pledged by New York capitalists, the secretary of State has announced that the "Executive Government of the United States has adopted the enterprise," has "provided for a full, satisfactory, and final survey, preparatory to the construction" of the canal, and is now "negotiating with the Republic of Columbia for its consent" to the undertaking. While these negotiations are not yet complete, their result can be foretold from a decree of the Colombian Congress, made in 1867, fixing the basis for the concession of the privilege of making a canal across the isthmus. The main conditions are that the duration of the privilege shall be for ninety-nine years, reckoning from the day on which the canal shall be opened to public service, in whole or in part; that fourteen years from the date of the concession shall be allowed for the completion of the work; that the canal shall have breadth and depth enough for vessels of the heaviest tonnage now in use, the *Great Eastern* alone excepted; and that the ports at each end of the canal shall be free and open to the commerce of all nations. No duties are to be collected by the Government of Colombia for the transit of vessels or goods; passports will only be required during war; the canal and its ports are to be always neutral; and the passage of war vessels on hostile errands is forbidden. The grantees of the right to construct the canal may fix their tariff of charges, provided it shall not exceed 75c. per ton for empty vessels, 2 dols. a ton for cargo, 10 dols. for each passenger, and half of 1 per cent. on precious metals. In return there is to be paid to Colombia 6 per cent. of the clear profits every year for the first twenty-five years, and 8 per cent. during each year of the remaining seventy-four, provided this percentage shall never be less than 600,000 dols. annually. An arrangement is made with England, Prussia, Holland, France, and the United States, to guarantee the neutrality of the canal. The route is not yet selected, and will depend on further surveys. The isthmus varies from 47½ to 114 miles in width.

Proposed Improvements in Dublin Harbour.—The new board of Harbour

Commissioners have in contemplation some very important improvements in Dublin Harbour. Some of the board's recommendations cannot be carried out until the lease of the custom-house dock expires; but there are other extensive and valuable improvements which will be commenced as soon as practicable. It is proposed to borrow about £98,000 or £100,000 from the Public Works Loan Commissioners for the purpose of constructing an additional graving dock, and executing various works on the south side of the river. The dock is estimated to cost between £50,000 and £60,000; and the remainder of the loan is to be applied to the other works. A tramway for the use of the gas company is also intended to be constructed. Should the board succeed in obtaining complete control over the Ringsend docks, it is contemplated to have only two instead of three entrances as at present; the two to be of such increased width and depth as to enable vessels of the largest tonnage to enter the docks with perfect ease and safety. The board are especially anxious to have proper accommodation made for the corn trade, as the present arrangements are quite inadequate to meet the wants of that branch of the shipping trade. Foreign vessels are frequently in great difficulty in reference to the terms of the charter party, which require the cargo of grain to be discharged afloat. This difficulty the harbour commissioners hope to be able to remove. In order to provide greater facilities for the discharging of coal it has been suggested that the dock should be extended to the lattice bridge across the canal, and thus give space for an additional number of coal vessels. This arrangement would relieve the river, and considerably diminish the heavy coal traffic which at present passes over Carlisle bridge. The board also contemplate promoting a new bill for authorizing various alterations in the pilotage arrangements of the ports, to provide transit sheds, warehouses, and other works. Considerable changes are also intended to be made in the harbour of Balbriggan, including a deepening of the harbour, extended quayage accommodation, and so forth. These improvements will be of considerable advantage to the trade of the district.

Splitting Masses of Rock, etc.—The breaking or separation of large masses of stone into smaller fragments may be said to include the various processes of blasting, the use of wedges and similar means commonly employed in mining operations, as in the coal regions of this country, the salt mines of Poland, and in marble, granite, and other quarries. These means are very often employed to subserve purposes of a similar nature, but of far less magnitude, in the removal of rocks and boulders from cultivated fields, highways, &c., or in reducing the size of such boulders to fit them for building uses or for the fabrication of stone fences and the like. Inasmuch as the employment of powder or other explosives, as in blasting, is always attended with some danger and frequently, in the cases last indicated, fails to accomplish its object, and the use of wedges is equally uncertain and far more laborious, a brief mention of more simple and at the same time equally efficacious means may be of interest to any who may have work of this character on their hands. One of the oldest and best-known means of splitting rocks in the direction of their strata is that which depends upon the expansion of thoroughly dried wood, when wetted or caused to absorb moisture. A crevice being formed or found in the mass at the point where it is desired to separate the same, has driven tightly therein a slightly wedge-shaped billet of seasoned wood, which when thus compressed between the walls of the crevice is wetted, and by expanding forces apart the strata on either side and effectually ruptures the rock. It is a matter worthy of a slight mention that while a piece of dry wood will thus expand by wetting, a dry hemp rope will be caused to contract in length by the same agency, a property which is sometimes taken advantage of in raising heavy weights for short distances. When it is required to separate the rock transversely to its lines of stratification a much greater power is required, generally necessitating the application in some form of mechanical force. One method that has been used to advantage in some cases is to drill a vertical hole in the mass, fill it partially with water, and closely fit into the same, above the water, a steel mandrill. A heavy blow from a sledge or from the falling hammer of a pile-driver upon the mandrill causes the water to exert a sudden lateral pressure which ruptures the rock. The great objection to this apparently simple plan is the nicety required in properly adjusting the mandrill in the bore, which of necessity requires more perfect tools and appliances than are commonly available where these boulders and masses of rock most do congregate, and where their removal is most to be desired. In speaking of the uses of water in this connection, we may instance a method of employing it for the function under consideration which has been found serviceable where the cold of winter is severe. The vertical bore in the rock is tightly closed, after being filled with water, with an iron plug, and the expansion of the water when converted into ice exerts a force which in some cases is almost resistless, and effectually secures the end proposed. Still another method, requiring perhaps less skill in its practical carrying out than either of the others just noticed, is that in which the hole or bore formed at a suitable point in the rock, as above described, has fitted into its lower portion an ingot of lead of corresponding shape and size in its transverse section. A mandrill of similar form and of hardened steel is then placed in the bore with its upper end projecting out therefrom. The mandrill is then subjected to repeated blows from a hammer or sledge, each one of which increases the lateral expansion and consequent pressure of the lead; and inasmuch as the latter, from its peculiar inelastic nature, fails to resume its original position after each blow, it follows that the accumulated pressure at last becomes so great that the rock gives way and is separated into two or more pieces, which if desired may be again divided through the same agency.—*American Artizan.*

Aluminium Bronze.—At the meeting of the Academy of Sciences at Paris on the 30th of November, the Count of St. Cricq-Cazeanx proposed to cover the worn-out steps of the column in the Place Vendôme with thin sheets of aluminium bronze. M. Dumas approved of the idea, and reminded the meeting how successfully this bronze was now being used in various kinds of mechanism, especially in saws driven by steam power, which saws, although much thinner, lasted a much longer time than those of steel.

A Strong Stone Cement.—A cement of great binding power, it is stated by Böttger, is made by using infusorial silica in place of quartz sand. This infusorial earth is found in Germany only, but it has been imported into this country in considerable quantities It consists of hydrated silica, which combines with bases much more readily than silica in the anhydrous condition, as in quartz sand. The infusorial silica is mixed in about equal proportions with oxide of lead; about half a part of freshly-slaked lime is then added, and the whole is then made into a paste with boiled linseed oil. The cement thus made quickly becomes as hard as sandstone, and will be found extremely useful in such work as fixing iron in stone for balusters and railings. It is not likely to expand in setting, and thus no risk of splitting the stone will be incurred. In this respect alone it offers advantage over Portland cement, sometimes used for the purpose mentioned, which according to some does expand, and in consequence of which one very serious accident is supposed to have resulted.

A New Natural Pigment.—A new pigment is stated to have been brought into use in America, which is likely to have an important influence on the white lead trade. In a mine in the state of New Jersey, which has for thirty-five years past been worked for lead, a natural chemical combination has been discovered, not heretofore attainable by any known artificial means, and which is not only suitable as a paint for ironwork of all kinds, but is specially adapted for the coating of ships' bottoms, as the particles of copper in the combination are fatal to animal life. Messrs C. & J. Reynolds, of New York; the Boston White Lead Company, of Boston; and J. S. Chadwick & Co., of Detroit—are contractors for the entire product of the mine, and the tests applied to it are alleged to have demonstrated that the material is "superior to any pigment hitherto made, for firmness, body, and durability, and, in fact, in every essential necessary to form a perfect paint."

Remarkable Relation between the Magnetism of some Metals, and their Atomic and Specific Weights.—By P. H. Van Der Weyde, M.D. When we divide the specific gravity of the different metals respectively into their atomic weights, we obtain quotients which indicate, not directly, but relatively, the distance of their atoms (upon the supposition that the atomic weights indicate really the relative weights of their atoms, which is probable, but not proved). Comparing those quotients in the subjoined table, we find the following remarkable results:

	Specific Gravity.	Atomic Weight.	Quotient.	
Cobalt,	8·5	30·	3·53	remains paramagnetic at white heat.
Iron,	7·8	28·	3·59	is only magnetic below bright red do.
Chromium,	6·8	26·	3 82	" " " dark "
Nickel,	8·	31·	3·90	" " " 600° Fahr.
Manganese,	7·	27 6	3·94	" " " 4° Fahr.
Palladium,	11·8	53·	4·49	
Platinum,	21·5	99·	4·57	
Zinc,	6 8	32·5	4·78	
Aluminium,	2·56	13·7	5·35	
Iridium,	16·	99·	6·2	
Cadmium,	8·7	56·	6·4	
Magnesium,	1·74	12·	7·	
Mercury,	13·5	100·	7 47	
Lead,	11·4	104·	9·12	
Osmium,	10·	100·	10·00	
Gold,	19·4	106·	10·005	
Silver,	10·47	108·	10·3	
Lithium,	0·593	6·4	10·9	
Antimony,	6·7	130·	19·4	
Bismuth,	9·8	208·	21·22	

OBSERVATIONS.

1st. The five magnetic metals have all quotients below 4. 2nd. The so-called non-magnetic metals have all quotients above 4. There is, however, one exception to this rule in the case of copper, of which the respective specific and atomic weights are 8·8 and 31·7, of which the quotient is 3·602; but then it is probable that the atomic weight of copper needs correction, and should be doubled to 3·4, in which case the quotient would be 7·204, and it would then fall among the other non-magnetic metals. 3rd. The quotients are the smallest for those metals which are the most permanently magnetic, even at high temperature, and *vice versâ.* 4th. As cooling increases by contraction the number expressing the specific gravity, it will consequently decrease the quotient obtained by using this increased specific gravity as a divisor, in perfect accordance with the fact that cooling increases the paramagnetic property. 5th. As, inversely, heating decreases by expansion the specific gravity, it will increase this quotient, in accordance with the fact that heat diminishes paramagnetism, and finally destroys it in all metals with the single exception of cobalt, which has the smallest quotient of all, and consequently can stand some increase. 6th. The experiments of Faraday on diamagnetism and paramagnetism, with very powerful electro-magnets, have proved that palladium and platinum are the strongest paramagnetic next to the first five in the above list; they have in my list, also, the smallest quotients connected with them. 7th. In the same way as diamagnetism is the opposite of paramagnetism, the larger quotients in the above table belong to diamagnetic bodies, as, for instance, mercury, antimony, and bismuth. The last is the strongest diamagnetic substance experimented upon, and possesses the greatest quotient in the above table. 8th. If we were able to cool the other metals so as to increase their specific gravities to such a degree as to have a decided effect on the amount of this quotient, we might perhaps succeed in discovering in several of them paramagnetic qualities, by means of Faraday's apparatus. 9th. Heating decreases the paramagnetic qualities, with the specific weight, and consequently increases the quotient. That it may do this to such a degree as to make the body diamagnetic, is proved in the case of oxygen gas, which when cool is paramagnetic like iron, and when hot, diamagnetic like bismuth. 10th. That this relative distance of the atoms (upon which, of course, the specific gravity of bodies depends) is closely related to their magnetism, is again proved by their crystals, which are always less dense in the direction of their optical axis, and expand by heat more in one direction than in another, and by Pluecker, who has demonstrated that they are diamagnetic in the direction of their optical axis, or of the longest axis of crystallization. In some of these crystals this action is so strong, that they are influenced by the magnetism of the earth; as, for instance, a properly cut crystal of kyanite (a dense silicate of alumina) when suspended on an axis, will behave like a compass needle, and may be used as such: a fact little known, but worth knowing.

Cerium.—This metal has lately been separated by Woehler from the double chloride of cerium and potassium by means of sodium. Formerly it was prepared by subjecting pure protochloride of cerium to the action either of potassium or sodium. Cerium is found in comparatively rare minerals, and generally associated with the metals lanthanum and didymium. Cerium tarnishes in air at ordinary temperatures, and displaces hydrogen in boiling water. The pure metal is therefore valueless, except as a reagent. It forms numerous oxides and salts, none of which have, as yet, been much used in the arts. Cerium has a darker blue than lead, and is only about one-half as heavy.

Colorado.—The coal question, which has had an important bearing upon our railway interests, says the *Denver News*, seems to be definitely settled. There is now no doubt but that enough of this article exists on the present line to prevent further fear on this subject. On Saturday evening General Pierce stated to the Board of Trade that, beside the vein of thirty-one inches discovered near Fort Dupton on the Platte, there were also two veins on the Cache la Poudre, near our railway line. One of these veins was four feet thick, and the other was about eighteen inches. Some one who had been working there said it was nine feet thick, but for this statement there was, as yet, no certain evidence. The existence, however, of coal in such quantities on the line, settles the railroad question definitely. The *Salina Herald* says that, in digging a well on the east side of the Smoky Hill River, less than two miles from town, a vein of good bituminous coal, eighteen inches thick, and about twenty feet below the surface, was dug through.

Aqueducts for the Supply of Paris.—A second enormous reservoir for the supply of Paris with water is now in course of completion at Montrouge; this is to receive the waters of the river Vanne, which will be brought to the capital by means of an aqueduct which will be remarkable not only as a fine specimen of construction and a picturesque object in the landscape, but also in an historical point of view. This aqueduct crosses the picturesque valley of the Bièvre, and is constructed upon the arches of the aqueduct of Arcueil, originally built to bring the water from Rungis for the gardens and fountains of the Luxembourg. In the time of Henri Quatre, the Minister Sully caused researches to be made to discover whence the Romans obtained water for the Palais des Thermes, the remains of which are annexed to the museum of the Hôtel Cluny, but it was not until the year 1643 that the works were commenced for bringing water from Rungis to Paris. The aqueduct was designed by Jacques Desbrosses, executed by Jean Coing, at a cost of £18,400, and terminated in 1684; it is on the old arches of this aqueduct that those of the new one are being constructed.

The Snow-sheds of the Pacific Railroad.—The "snow problem" on the Central Pacific Railroad is not yet solved. The company last winter built sheds for the protection of their tracks over the Sierra Nevada. These sheds were, however, crushed by snow. The company are now engaged in constructing new sheds, with frame-work of heavy timber and pointed roofs About forty miles of track will require to be covered, and it is stated that twenty-two saw-mills, most of them worked by steam, are running night and day, employing nearly two thousand men, and six more are building. It is estimated that it will require eight hundred thousand feet of timber to the mile for the sheds.

Decimal Coinage in Italy.—The value of the money coined in Italy from September, 1862, to 30th June, 1868, was as follows:—

	frs.	cents.
Gold coin, ...	200,132,000	0
Silver coin, ...	165,062,825	0
Bronze coin, ...	65,573,980	14
Total frs., . .	430,768,805	14

The following is the value of the old coinage of the various Italian States withdrawn from circulation during the same period:—

	frs.	cents.
Piedmont and Sardinia, ...	27,607,014	84
Lombardy, ...	4,722,227	95
Parma, ...	1,247,234	48
Modena, ...	524,762	66
Rome and Bologna, ...	54,842,071	79
Tuscany, ...	84,123,802	37
Naples and Sicily, ...	155,653,253	98
Venice, ...	4,514,029	50
Foreign coin, ...	16,124,436	55
Total, . . .	349,358,834	12

Railway Orchards.—A proposition is now before the French railway companies to plant the slopes of the railways with fruit trees. The plan suggested is to support the trees, pear, gooseberry, &c., according to soil and position, on light iron espaliers. The cost of cultivation is estimated at less than sixpence a yard. The idea is not quite new, for in certain parts of Germany and in the Grand Duchy of Luxembourg the lines are bordered with fruit trees. Nothing is to be said against such an economical arrangement, but many travellers on the French lines will regret the lilacs, syringas, and other shrubs and flowers, which now flourish there in many places.

Copper at the Cape of Good Hope.—The first discovery of copper in Kafirland was in a part of the Insizwa Mountains, at a point about twelve miles from the southern boundary of Natal. The mountain itself has an area of about one hundred square miles, and is situated on the right bank of the Umzimkulu, a branch of the Umzimvubu. The mine is not more than eighty miles from Port St. John, and the road between the two places could be easily made good throughout. About ten miles to the south-west of Insizwa there is another mountain of the same character, which is said to contain copper. This mountain is also near the same feeder of the Umzimvubu. When Dr. Sutherland, surveyor-general of Natal, visited the mines, the quantity of ore excavated was about one-quarter of a ton, all taken from the surface. By the aid of natives the main vein was laid open, and traced into a mountain to a distance of eleven feet. This vein is about eighteen feet thick by two and a half feet in depth. The ore is replaced by a yellow ochreous deposit containing nodules of very pure carbonate of copper or malachite, varying in size from a pea to masses of ten or fifteen pounds weight. At a vertical height above the vein masses of ore are found very different from that in the vein itself. The ore varies in quality, the chief impurities being iron and clay. In one section of the rock there is a perceptible infiltration of carbonate of copper, filling all the fissures in the lines of cleavage. This has been traced to a depth of one foot. A party of miners from Durban subsequently carried the excavations seventeen feet further into the mountain, when the vein was again struck, and ore of superior quality obtained. Portions of considerable masses have been found to contain as high as 56 per cent. of metal, and others from 15 to 25 per cent., the average of all being 30 to 40 per cent. The mines are in Faku's territory, the Insizwa mountain being, however, occupied by the petty chief Jojo. It is this fact which makes it difficult for the Natal or Cape government to move in the matter. The per centage of copper is put down at 20·50 per cent. Silver was found to the extent of 5·30 ounces per ton of 21 cwt. A trace of gold was also detected. The value of the ore was placed at 14*s.* 6*d.* per cent., or £14 17*s.* 3*d.* per ton of 21 cwt.

Serrin's Electric Lamp.—Daylight being considered insufficient to enable certain of the Paris reconstruction works to be completed in the desired time, M. Haussmann has called in the aid of M. Serrin's beautiful apparatus for the automatic regulation of the carbon electrodes of electric lamps. The intensity of this light is such that it has been used with great success in obtaining photographs of the catacombs under Paris, and also of the sewers, and it is now employed to enable masons and other workmen to labour through the night hours.

Conversion of Iron into Steel and Semi-steel.—It is proposed to convert wrought iron into steel or semi-steel by a process which consists in submitting wrought iron to the action of gases under pressure in any suitable gas-tight vessel or receiver, such as hydro-carbons and carbonic oxide, either alone or in conjunction with nitrogenous compounds; such, for instance, as cyanogen gas, or ammonia, or other gases containing nitrogen in admixture, preferring, however, the former to convert it into semi-steel or steel, for the purpose of case-hardening it.

Immense beds of chromium have been discovered in Maryland and Pennsylvania

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APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

13th November, 1868.

3444 E. Owen, Blackheath—Night light cases
3445 W. Thomas, Cheapside—Boots and shoes
3446 B. P. Walker, Wolverhampton—Forging metals
3447 J. Dendy and J. H. W. Biggs, Manchester—Dressing machines
3448 R. A. Dalton and G. S. Barton, Coventry—Upholstery trimmings
3449 C. E. Brooman, Fleet Street—Wall coverings.—A com.
3450 J. Stephens, St. James'—Carriages
3451 C. Markham and W. Knighton, Chesterfield—Moulding pipes
3452 T. and A. Lawson, Leeds—Carding engines
3453 C. Markham and W. Knighton, Chesterfield—Drying moulds for pipes
3454 R. A. Gold, Birmingham—Two-wheeled carriages
3455 W. Burgess, Upton-on-Severn—Signal apparatus for protecting game
3456 A. J. Dehlon, France—Rotary steam engine
3457 C. Jones, Ealing—Treating sewage

14th November, 1868.

3458 W. N. Nicholson, Newark—Hay-making machines
3459 J. B. Green, Bury—Preparing yarns
3460 T. Mills, Plumstead—Steam generators
3461 W. Harrison, Fenton—Brick kilns
3462 P. Hill, Kensington Park Gardens—Electric telegraph apparatus
3463 G. J. Worssam, City Road—Obtaining motive power
3464 R. Beckley, Richmond, and J. J. Hicks, Hatton Garden—Measuring liquids
3465 H. E. Newton, Chancery Lane—Propelling vessels.—A com.
3466 A. Turner, Leicester—Elastic fabrics
3467 W. Richardson, Oldham—Carding engines
3468 J. Howard and E. T. Bousfield, Bedford—Tubular steam boilers
3469 C. K. Bradford. Massachusetts—Velocipedes
3470 J. C. MacDonald, Croydon, and J. Calverley, Camberwell—Stereotype printing surfaces
3471 H. Aitken, Falkirk—Treating iron ores
3472 J. H. Johnson, Lincoln's Inn Fields—Railway wheels.—A com.

16th November, 1868.

3473 T. Berney, Bracon Hall—Mounting ordnance
3474 J. C. Bowler, Bowden—Constructing castors
3475 H. A. Bonneville, Piccadilly—Casting missiles.—A com.
3476 J. Smith, Manchester—Stretching woven fabrics
3477 H. Carter, Manchester—Gas burners
3478 T. Martin, Dublin—Supplying ammunition to troops
3479 P. J. Ravel, Paris—Steam generator
3480 J. Matheson, Glasgow—Dyeing yarns
3481 E. and A. Priest, Huddersfield—Carding engines
3482 E. Hogg, Gateshead—Rolled iron
3483 J. Hare, Handsworth—Expanding tables
3484 A. M'Niel, Tiverton, and W. Wheaton, Exeter—Manufacturing salts of ammonia
3485 R. M. Boniwell, Richmond—River boats
3486 W. Low, Wrexham, and G. Thomas, Cardiff—Suspension bridges
3487 S. W. Campain, Lincoln—Tilling land

17th November, 1868.

3488 J. Jones, Stratford, and S. P. Bidder, Mitcham—Coal-breaking apparatus
3489 H. A. Bonneville, Piccadilly—Prognosticating the weather.—A com.
3490 R. Green, Bayswater—Covering telegraph wires
3491 G. H. Wilson, Commercial Road—Securing windows
3492 G. Montrichard, Paris—Transmitting motion
3493 J. E. H. Harris and T. Lumley, Paddington—Chimney pots
3494 L. M. Prewitt, Bristol—Stays
3495 W. R. Lake, Chancery Lane—Bayonet and digging implement combined.—A com.
3496 W. Mansfield, Birmingham—Brick kilns
3497 A. Clark, Chancery Lane—Ginger snaps.—A com.
3498 H. A. Kehoe, Kilburn—Railway signals
3499 C. Richardson, Gracechurch Street—Looms for weaving

18th November, 1868.

3500 J. M. Prichard, South Hackney—Fountain penholders
3501 C. W. Siemens, Westminster—Telegraph wires
3502 W. P. Nash, City—Postal bags.—A com.
3503 C. E. Brooman, Fleet Street—Wool-oiling composition.—A com.
3504 F. O. Ward, Mayfair, W. J. Ibbotson, New Inn, and A. G. Southby, Bulford—Drying alkaline solutions
3505 M. Wilkin and J. Clark, Paddington—Mining
3506 A. M'Dougall, Manchester—Sulphate of ammonia
3507 A. W. Drayson, Woolwich—Liquid cooling apparatus
3508 B. Bell, Regent's Park—Iron ships
3509 W. L. Groundwater, Plumstead—Percussion caps
3510 W. T. Bassett, Albion Street—Washing sheep

19th November, 1868.

3511 H. D. Hoskold, Cinderford, and G. P. Wheeler, Abinghall—Artificial fuel
3512 G. V. Fosbery, Cowley—Breech-loading fire-arms
3513 S. Crighton, Ashton-on-Mersey, and J. Taft, Manchester—Grinding cards
3514 W. Thompson, Dublin—Packing bottles
3515 C. D. Abel, Chancery Lane—Manufacturing phosphorus.—A com.
3516 H. Carrigg, Manchester—Manufacturing phosphate of lime
3517 W. Avery and A. Fenton, Redditch—Needle cases
3518 T. G. Webb, Manchester—Manufacturing tumblers
3519 D. Jones and J. Jackson, South Hackney—Imparting heat to the body
3520 J. M'Grath, Belfast—Shirts
3521 J. Green, Lisburn—Manufacturing rope

20th November, 1868.

3522 E. H. Bayley, Southwark—Snow carts
3523 J. M'Glashan, Dundee—Untwisting ropes
3524 J. D. Hopkins, Bedford Square—Window sashes
3525 D. Burns, Edinburgh—Treating diseases of the generative organ
3526 A. Guthrie, Craig—Ploughs
3527 A. Leykauf, Nuremberg—Colouring matter
3528 B. Britten, Red Hill—Fishing rods
3529 F. D. Sutherland, King William Street—Cravat holder
3530 W. Brookes, Chancery Lane—Lace machinery.—A com.
3531 H. B. Cowell, Islington—Water distributing apparatus
3532 W. R. Lake, Chancery Lane—Reciprocating saws.—A com.
3533 G. Eguillon, Paris—Suspending bells
3534 C. Descat and H. Guillaume, Paris—Fixing colours on textile fabrics
3535 A. V. Newton, Chancery Lane—Sewing needles.—A com.

21st November, 1868.

3536 W. R. Lake, Chancery Lane—Preparing chopped hay
3537 J. G. Tongue, Chancery Lane—Preparing yarns.—A com.
3538 J. Scholes and J. Leach, Huddersfield—Preparing wool
3539 C. D. Abel, Chancery Lane—Combined tobacco pouch & cigarette former.—A com.
3540 C. Smith and J. Macfarlane, Glasgow—Washing machines
3541 C. E. Brooman, Fleet Street—Manufacturing gas for heating.—A com.
3542 J. Sims, Liverpool Road—Applying ornaments to woven fabrics
3543 J. B. Harris, Edinburgh—Driving bands
3544 C. J. Foster, Maldon—Reaping and mowing machines

23rd November, 1868.

3545 F. W. Webb, Bolton—Steam hammers
3546 W. Inglis, Manchester—Steam engines
3547 J. Mangnall, Glasgow—Cradles and beds
3548 G. Bowden, Mossley, M. N. and B. R. Mills, Manchester—Carding engines
3549 W. La Penotière, Bartholomew Road—Constructing locks
3550 J. Hudson, Stockport—Steam engines
3551 E. T. Hughes, Chancery Lane—Presses.—A com.
3552 J. Howlison, Scarborough—Railway carriage sleeping berths
3553 C. Crabtree, Bingley, and J. Stell, Keighley—Paper tubes
3554 B. and B. T. Newnham, Bath—Folding steps for carriages
3555 W. H. Ibbett, Jewin Street—Inducing motion in mobile substances.—A com.
3556 W. A. Lyttle, Hammersmith—Electro-telegraphic apparatus
3557 J. Sturrock, Glasgow—Metallic caps for bottles
3558 C. Montagu, Cannon Street—Pianofortes
3559 A. V. Newton, Chancery Lane—Dressing millstones.—A com.
3560 W. E. Newton, Chancery Lane—Felted fabrics.—A com.
3561 J. R. Swann, Leith Walk—Lime kilns
3562 T. Smith, Cheltenham, and J. V. N. Bazalgette, Portland Place—Deodorizing sewage
3563 W. H. Dreaper, Liverpool—Pianoforte hammers
3564 J. E. Phillips, Grantham—Sewing machines
3565 C. D. Abel, Chancery Lane—Converting cast iron into wrought iron.—A com.

24th November, 1868.

3566 T. Culpin, Reading—Reaping and mowing machines
3567 J. H. Johnson, Lincoln's Inn Fields—Safety tackle.—A com.
3568 W. G. Beattie, Surbiton—Slide Valves
3569 C. W. Siemens, Westminster—Iron and steel
3570 W. Carter, Masham—Communicating in railway trains
3571 T. Prideaux, Sheffield—Constructing sea walls
3572 W. Dinwoodie, Laurick Castle—Fences
3573 H. E. Newton, Chancery Lane—Atmospheric hammers.—A com.
3574 H. E. Newton, Chancery Lane—Multiplying motion.—A com.
3575 E. R. Wethered, Shorncliffe—Signalling in railway trains
3576 B. Solomons, Albemarle—Meteorological indicators

25th November, 1868.

3577 B. Hunt, Lincoln's Inn—Watches.—A com.
3578 J. Parry, Manchester—Spring mattresses
3579 R. Lakin and W. H. Rhodes, Manchester—Spinning machines
3580 W. Wild, Oldham—Motive power engines
3581 G. Bernhardt, Radcliffe—Regulating the supply of gas in mills
3582 T. Craig, Lincoln's Inn—Supporting windows
3583 P. Spencer, Newcastle-upon-Tyne—Indigo blue
3584 W. R. Lake, Chancery Lane—Manufacturing cigars.—A com.
3585 S. Brook and C. Thompson, Halifax—Looms for weaving
3586 D. S. Merry, Hackney—Arm protectors
3587 W. F. Chapman, Llandudno—Packing-boxes
3588 G. Baker, Birmingham—Bird cages
3589 W. E. Gedge, Strand—Tug boats.—A com.
3590 W. E. Gedge, Strand—Embroidering machine.—A com.
3591 H. Smith, Westbourne Terrace Road—Playing games
3592 E. T. V. Hecke, Paris—Steam boilers
3593 N. D. Spartali, Liverpool—Steam boilers
3594 J. Bourne, Leith—Producing heat
3595 H. Milsted, City Road—Belt buckles
3596 W. R. Lake, Chancery Lane—Sad-irons.—A com.
3597 D. Vogl, Basinghall Street—Fastening scarfs.—A com.
3598 E. Ellenband, Manchester—Domestic needles.—A com.

26th November, 1868.

3599 L. Roman, Paris—Hydraulic motive power
3600 F. Holt, Gorton—Steam engines
3601 P. Panton, Hyde Park—Fire arms
3602 A. M. Clark, Chancery Lane—Sizing threads.—A com.
3603 J. Sincock, Birmingham—Ratchet braces
3604 H. Swithenbank, Cheapside—Manufacturing hats
3605 C. E. Spooner, Port Madoc, and G. A. Huddart, Brynker—Railways.—Partly a com.
3606 A. Busche, Schwelm—Lace-making machinery
3607 E. T. Hughes, Chancery Lane—Dressing stone.—A com.
3608 H. Pollack, Hamburg—Breech-loading fire-arms
3609 W. R. Lake, Chancery Lane—Paddle wheels.—A com.
3610 W. R. Lake, Chancery Lane—Harvesting machines.—A com.
3611 J. H. Moreland, Belfast, and J. Coulong, Blackburn—Pneumatic looms.—A com.
3612 A. Harris, Thame—Warming churches

27th November, 1868.

3613 E. Stevens, Islington—Sharpening knives
3614 J. S. Templeton, Glasgow—Brussels carpets
3615 A. C. Bamlett, Thirsk—Reaping and mowing machinery
3616 T. G. Webb, Manchester—Tumblers
3617 J. Petrie, Rochdale—Washing wool
3618 L. Dickens and H. Heywood, Middleton—Washing silk
3619 W. E. Newton, Chancery Lane—Oil cups.—A com.
3620 J. H. Dales and J. F. Maygrove, Wood Street—Looms for weaving
3621 A. M. Clark, Chancery Lane—Paper clips.—A com.

28th November, 1868.

3622 W. Tranter, Birmingham—Breech-loading fire-arms
3623 J. Ingham and J. Butterfield, Bradford—Dressing warps
3624 E. S. Samuel, Liverpool—Superphosphate of lime
3625 A. Wyllie and J. Latham, Liverpool—Cracking palm nuts
3626 H. J. H. King, Glasgow—Gauges
3627 J. Cornes, Ilford—Grass-mowing machines
3628 A. N. Burton, Reading—Fastening boots
3629 W. E. Gedge, Strand—Perspectometers.—A com.
3630 W. E. Gedge, Strand—Plate-warming apparatus.—A com.
3631 C. D. Abel, Chancery Lane—Steel.—A com.
3632 J. Saward, Islington—Preserving natural flowers
3633 J. L. Norton, Ludgate Hill—Dyeing and printing
3634 J. Heaton, Langley Mill—Treating cast iron
3635 W. Naylor, Mildmay Park—Railway breaks
3636 G. S. Brown and E. Turner, Leicester—Communicating in railway trains

30th November, 1868.

3637 W. Soper, Reading—Breech-loading fire-arms
3638 L. Pfeiffer, Walbrook Buildings—Locks for bags.—A com.
3639 J. S. Forbes, Stoke-upon-Trent—Manufacturing pottery
3640 T. Hill, Euston Road—Organs
3641 R. A. Green, Strand—Ornamenting articles of plate
3642 A. M. Clark, Chancery Lane—Manufacturing tiles.—A com.
3643 D. Greig and J. Fernie, Leeds—Casting plough heads
3644 N. and R. G. West, Upper Norwood—Preserving rudder pins from corrosion
3645 J. Myers and L. L. Morrison, Leeds—Constructing bats
3646 W. Maclellan, Glasgow—Fastenings for rails
3647 J. W. Reid, Paddington—Bleaching vegetable fibre
3648 W. E. Newton, Chancery Lane—Cleaning cotton.—A com.
3649 A. V. Newton, Chancery Lane—Receiving mail bags on railways.—A com.
3650 A. Ransome, Chelsea—Circular saw benches
3651 J. H. Johnson, Lincoln's Inn Fields—Substitutes for wood.—A com.

1st December, 1868.

3652 H. A. Bonneville, Piccadilly—Mineral teeth.—A com.
3653 W. Betts, City Road—Capsuling bottles
3654 W. Brookes, Chancery Lane—Lace fabrics.—A com.
3655 J. B. Shillcock, Bromley—Securing bottles
3656 S. A. Daniell, Birmingham—Cleaning bottles.—A com.
3657 E. Price, Cheapside—Shirt fronts and collars
3658 J. H. Johnson, Lincoln's Inn Fields—Carding engines.—A com.
3659 H. W. Fuller and J. W. Barnum, New York—Sewing machines
3660 J. Grindrod, Neston—Screw ships

2nd December, 1868.

3661 C. S. Rostaing, Paris—Electric telegraph cables
3662 P. Ellis, Liverpool—Letter boxes
3663 P. Ellis, Liverpool—Omnibuses
3664 J. Tidmarsh, Twickenham—Clipping horses
3665 T. Warburton, Haslingden—Piecing cardings of cotton
3666 E. Hely, Dublin—Envelopes
3667 J. Alexander, Westport, and J. Hill, Dublin—Signalling on railways
3668 H. N. Maynard, Crumlin—Girders for bridges
3669 S. C. Lister, Bradford—Weaving velvets
3670 S. Pallant, Regent Street—Fastenings for stays
3671 T. B. Hubbell, Euston Square—Oil lamp reflectors.—A com.
3672 P. Hooker, Old Street Road—Brick-making machinery
3673 A. M. Clark, Chancery Lane—Paving blocks.—A com.
3674 E. W. P. Taunton, Birmingham—Chairs.—A com.

3rd December, 1868.

3675 D. Dorrity, Rouen—Locking printer's forms
3676 L. J. Marechal, Bishopsgate Street Without—Safety locks
3677 H. W. Grylls, Great Saint Helen's—Obtaining motive power
3678 W. Pugh and J. Field, Bow Street—Lenses for defective visions
3679 W. E. Gedge, Strand—Ploughs.—A com.
3680 J. H. Banks, Knutsford—Constructing buildings
3681 J. Littler and J. H. Banks, Knutsford—Constructing furnaces
3682 C. H. Chadburn, Liverpool—Drawing instrument
3683 R. Hornsby and J. E. Phillips, Grantham—Reaping and mowing machines
3684 H. Kinsey, Nottingham—Steam boilers
3685 W. Simpson and J. Hutton, Northampton—Lubricating apparatus

4th December, 1868.

3686 W. R. Lake, Chancery Lane—Knitting machines.—A com.
3687 W. R. Lake, Chancery Lane—Cutting edible roots.—A com.
3688 H. Robinson, Lewisham—Dressing millstones
3689 S. Hirsch, Glasgow—Dyeing yarns.—A com.
3690 R. Charles, Birmingham—Thimbles
3691 J. H. Johnson, Lincoln's Inn Fields—Medicated vapour for treating diseases.—A com.
3692 J. G. Rollins, Upper Thames Street—Nozzles for oil cans.—A com.
3693 W. G. Ainslie, Leadenhall Street—Drying peat
3694 M. P. W. Boulton, Tew Park, and J. Imray, Westminster Bridge Road—Rotary propellers
3695 H. L. D. Marsdon, Louth—Washing photographic prints
3696 J. S. Capelle, Paris—Perpetual calendar to desks
3697 F. Beech, Salford—Stench traps
3698 A. C. Sterry and F. Lambe, Rotherhithe New Road, and J. Fordred, Blackheath—Treating paraffine
3699 J. R. Swann, Leith Walk—Calcining limestone

CIRCULAR SAW BENCH,

JOHN CASSON,
PATENTEE.

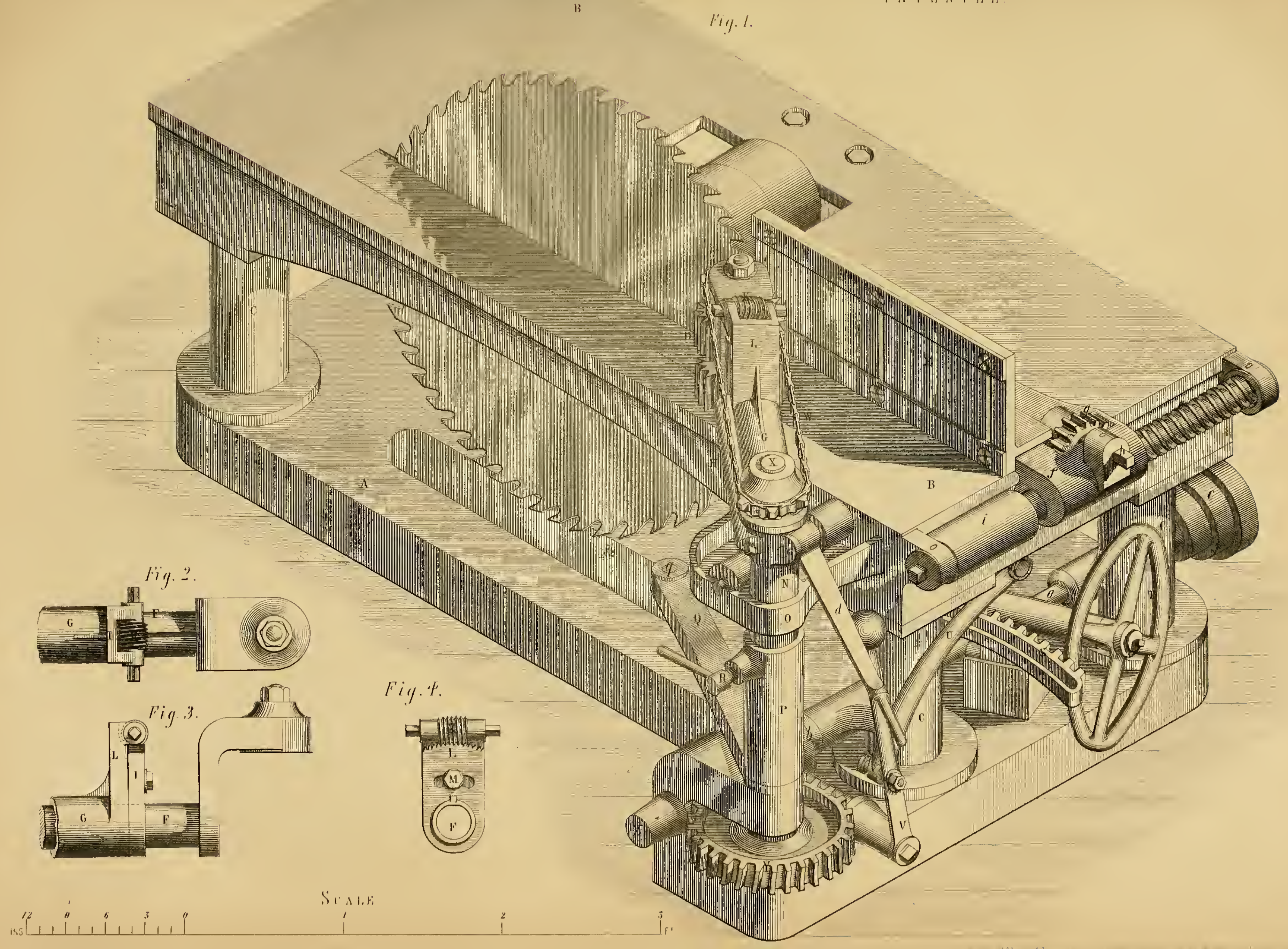


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

SKETCH OF RECENT IMPROVEMENTS IN THE SCIENCE AND PRACTICE OF THE METALLURGY OF LEAD.

The methods for the reduction of lead from its ores, and the secondary treatments which the nature of the metal itself at high temperatures gives rise to, as well as those incidental to the foreign metals with which in reduction it becomes alloyed, are amongst those which ought to possess the very highest interest to the smelter, as they certainly do to the scientific metallurgist; for amongst the entire range of the metals of commerce there is scarcely one as to which the loss as well as the deterioration in smelting may become greater in proportion to the product, nor in which science is more effective in pointing out the causes of loss and the means to prevent it.

Yet, notwithstanding that this is obviously so, and that the smelting of lead reaches the vast total, annually, of about 70,000 tons for Great Britain, not much less for Spain, and perhaps 50,000 tons more for the rest of the world, exclusive of America; there are many places, some even in our own islands, in which, through mere tradition and the inertness that a long-continued moderate success engenders, the least advantageous methods are still practised against all scientific light.

Although a large catalogue of plumbic minerals is to be found in every systematic mineralogy, there may be said to be actually but about five ores produced in sufficient abundance for the smelter: viz., sulphuret of lead (or galena), carbonate of lead, sulphate of lead (both naturally decomposed galenas), chloro-phosphate of lead (pyromorphite), and molybdate of lead (or yellow ore, as it is commonly called by the smelter); and of these galena, in fact, constitutes the great staple supply.

The methods of smelting, from that which no doubt constituted the very earliest, and which may have dated long before Tubal Cain's imagined epoch, to the most recent, may be classed into four:—1. The smelting upon the open hearth supplied with blast, which may be carried on upon a very small, as well as on a very large scale, and with fuel as inferior as turf or even brushwood. The oldest form of this was fed with cold blast, and lime in powder was not uncommonly thrown on with each charge of ore. The latest form is that which has been now a good while in operation in the United States, fed with hot blast and with green timber for fuel, and employed for smelting, not without great waste, the enormous deposits of galena of that country. The first form is still in use in Ireland (we believe), in Scotland, the North of England, and in certain parts of France and of Italy; the second has been used in Europe, in Carinthia. At Przibram and Bleiberg the galena contains at an average 75 per cent. of lead, and of this about 10 per cent. is wasted or lost by this process. The reaction is the simplest possible; it is precisely that by which we reduce a crystal of galena on charcoal with the blowpipe. Under the oxidizing flame and before fusion we burn off the sulphur, the lead remaining protected in great part from oxidation at the same time, by the influence of the carbon. In the end, we act with the neutral or deoxidizing flame and fuse the metal. The whole of the sulphur is lost, much lead, as volatile oxide or "fume;" and where the galena is mixed with much quartz or other difficultly fusible foreign bodies, much lead is entangled in these and mechanically lost, and when recovered by the subsequent smelting of the dross or slag suffers necessarily a further loss. Unless with the most perfectly pure galenas this process is a lavishly wasteful one, and unless where local circumstances, such as difficulty of transport, or want of fuel, with an exhaustless abundance of the galena exist, it is one that ought to be abandoned everywhere.

The choice of one or other of the remaining methods is determined, not alone by such conditions, but also by the nature of the foreign admixtures present in the ores. Thus, where these are in considerable amount and of difficult fusibility, the cupola or high-blast furnace may be employed with advantage; but in most instances the reverberatory furnace, worked upon one or other of two different principles or methods, appears to be the mode of smelting most advantageously applicable to the greatest variety of lead ores. The two reverberatory methods may be briefly said to consist in, roasting, reaction, and fusion, or in roasting and reduction to metal, either in a second reverberatory or in cupola with blast.

Rich pure ores, not very quartzose, are always best treated by the first of these methods, and Gruner, in a late elaborate review of the whole metallurgy of lead in the "Annales des Mines," considers that the work is best performed in very large reverberatory furnaces with a single fire grate, provided with a "sump" for reception of the lead at the coolest part of the furnace, and with abundant access of air; that the operation should be conducted slowly; and in the two well-marked stages of roasting and of reaction, in order that the first be done with perfection, the bed of ore operated on in the furnace must not exceed 3 to 4 inches in depth, and that the roasting must be conducted at so low a temperature as shall avoid all incipient fusion. It should be carried to the full theoretic limit of one equivalent of sulphate or two of oxide for each equivalent of sulphuret of lead in the ore, by average assay.

After the first strong heating, which gives a run of lead in the "sump," the roasting heat is to be again urged two or three times, and then the whole of the dross, still rich in lead, be raked out of the furnace, which is to be newly charged; the dross being remelted in a separate air furnace, or by blast. The object here is to avoid that hardening and injury to the quality of the reduced lead, which results from the melting of the drosses by a much raised temperature, or *réssuage*, in the same furnace, whereby the less fusible metals present become diffused in the mass.

With poor ores the roasting is sometimes done in long heaps, or in large conic or prismatic ones—the former at Müsen-Rothenbach, and in the Hinterartz, the latter at the Rhone smelting-works, those at Fahlun, &c.; but where fuel is abundant it always pays best to roast in large furnaces. In either case the sulphur is got rid of partly by atmospheric oxygen, partly by the reaction of the oxidized constituents of the mass operated upon.

There are four varieties of working on the reverberatory system, viz.:

a, the English method, in use in England and Wales, mainly that employed in Spain, and, we believe, in some parts of Germany. This answers for rich ores coming from the limestone formations. Metallic lead is produced, as well as a very fusible slag of basic sulphurets and oxysulphurets of lead with lime, silex, &c., and these are decomposed by further additions of lime and small coal, and by a more powerful heat. This process, of course, will answer well with any rich ores that do not contain too much silex or clay in mixture, provided lime and fuel can be commanded; and in proportion to wages expended per ton of lead reduced, it seems to be one of the most advantageous.

b, the Carinthian method, which is in principle the same as the last, but in which a higher temperature is maintained by means of smaller reverberatories, so constructed with sloping hearths that the reduced lead continually runs off; the drosses, rich in oxide of lead, being reduced by small coal and heat alone.

c, the French method, now of considerable antiquity, having been long practised in Brittany, and since at Stolberg, in North Italy, &c., which is best applicable to the poorer ores, mixed with iron and copper pyrites and quartz. The smelting is pushed to fusion in reverberatory furnaces. A more or less moderate yield of metallic lead at once runs into the "sump," with a large amount of fused oxide (chiefly) of lead, which latter is then reduced by mixture with small coal.

d, the French (so-called) "precipitation process." This is the method often known as the "Vienne process," and which is still practised there and at the great smelting works at Marseilles, as well as in several other districts in France and other countries.

It is applicable to very quartzose or sandy galenas, and consists essentially in decomposing the sulphuret of lead by heat in presence of metallic iron, or of ferruginous oxides, and of the silica of the ore, with or without lime. Iron-turnings, or old scraps, hæmatites, finery cinder from the ironworks, have all been employed, and various curious local modifications, to suit special conditions, are made; as, for example, the employment of the roasted crude matt of the ore itself, or of the slags from previous operation, rich in oxide of iron, for the precipitation, *i.e.*, the isolation, of the lead.

Foreign sulphurets, such as of copper, are objectionable with this process, for the performance of which Gruner considers that lime is advisably employed as a flux, and that attention should be given to thoroughly roasting prior to the reduction, so as to avoid the formation of coherent matts, which rob much lead. The reduction by this method may be performed either in air furnaces or by blast, and Gruner gives the preference apparently to the latter. The reducing blast furnace, he says, should be narrow at the level of the twyers and circular in section, with water twyers, and a cast-iron double-walled water hearth. Covered furnaces, relieved of "fume" by a lateral aperture leading to a long condensing flue, are both most wholesome for the men and most economical of lead.

Blende, which is a very constant accompaniment of poor lead ores, is another of the foreign matters very objectionable in this method; and the most improved practice appears to be to "stamp" the ores thoroughly into impalpable powder or *schlich*, so that as much as possible of the zinc may pass off along with the scorias in the form of oxide, and to work the furnace rapidly and keep the furnace hearth well supplied with oxide of iron (within fixed limits, however), so as to reduce as little as possible of the oxide of zinc.

Gruner states, as the result of his examination, that the method by iron precipitation by blast, &c., should never be employed except where fuel is too scarce for reverberatory roasting, or where the galenas are largely mixed with sulphurets of copper. In the latter case, if they are also argentiferous, some preliminary roasting will prove in any case advantageous, as giving a smaller weight of matts. It may thus be seen that the common lead smelting process, and that which is most widely diffused in practice, is in fact a mixed one, consisting in roasting either in heaps or in reverberatories, and in reducing in blast furnaces with or without ferruginous reagents, and under many more or less significant local modifications. For these, as well as for the actual constructive details of the furnaces, &c., we must refer our readers to the systematic works of Rivot, "Metallurgie du Plomb et de l'Argent;" or of Kerl, "Huttenkunde;" of Dumas, "Chemie Applique aux Arts;" to the "Voyage Metallurgique en Angleterre," of MM. Dufrénoy and Elie de Beaumont; and to many able memoirs in the "Annales des Mines," the latest being that of M. Gruner, to which we have made frequent reference above.

The lead which has been produced by any one of these smelting processes is contaminated with more or less involved oxide, and with several foreign metals, with which lead has a powerful alloying tendency. These render the metal *hard*, as it is called in commerce, and when in certain proportions and with certain metals, the alloy becoming actually crystalline in texture, and more or less brittle. In the case of silver, too, as an adventitious metal, its intrinsic value makes it worth extraction. All these conditions further complicate the metallurgy of lead by the necessary introduction of a tribe of supplementary processes of lead refining. The oldest and simplest, but least perfect, were those of simple remelting, either on the sloping hearth of an air furnace of low temperature, or in open cast-iron pots, and by mere liquation, separating some of the foreign matters; the separated oxides, as in the case of copper refining, being reduced by fusion and "poling," *i.e.*, stirring with birch-wood poles, as practised in the Hartz still.

Cupellation on the great scale, *i.e.*, of the whole mass of crude lead, where the lead was rich enough to make it pay, was practised all over Europe for centuries, but is now (everywhere, we believe) abandoned, so far as raw pig lead is concerned. We cannot enter into the specialities of refining by furnace remelting, which are necessarily introduced when the lead contains, in addition to oxide, some sulphuret, iron and copper, also zinc, arsenic, and antimony. For such leads altogether special furnaces and methods are employed at Marseilles, at Stolberg, and in Belgium, as well as, we believe, at Carthagena in Spain.

A recent improved method of refining has been invented, and is employed by M. Cordurie, of Toulouse, which consists in the exposure of the fused raw lead at a red heat to superheated steam. This method is adopted to refine and soften the leads from which silver has been removed by means of the beautiful process of alloying with zinc, which we are about to describe; and it is found rapidly to oxidize and remove, iron, zinc, and even antimony, and with but very slight oxidation of the lead itself.

Another recent and beautiful, as well as powerful process of refining, is that of Mr. Baker, of Sheffield, which consists in submitting the fused raw lead at a red heat to the action of nitrates of potassa or of soda; the latter, especially, fuses at a low temperature (much below the melting point of lead), and evolves oxygen which removes the more oxidable metals. There can be not much doubt that the extreme softness and purity of the lead thus treated is in part due to the introduction of a minute proportion of sodium, which alloys with the lead itself.

Two methods of desilverizing or disargentizing lead are both in extensive use—that invented by Mr. Pattinson, and that known in England, at least, as that of Parkes, by the aid of zinc.

Up to 1833, or thereabouts, when the late Mr. Pattinson patented his process, cupellation, conducted as it probably was a thousand years before, was the only method of taking the silver out of raw lead, and unless the content of silver was very large, from 0·10 to 0·15 per cent., or so, the process would not pay, and the silver passed with the lead, and to the physical deterioration of that, along with it into commerce.

Now, any raw lead which contains from 0·05 down to 0·03 per cent. of silver will pay to desilverize by Pattinson's process. It has been justly pronounced the most important metallurgical invention made during the present century; possibly we may except, or at least place upon the same line with it, Bessemer's steel-making, and, should all that is anticipated be hereafter realized, also Siemen's and Heaton's steel-making methods, which latter, as we may above see, is based upon the same play of affinities as is Baker's lead-refining process by nitrates.

Pattinson's process most persons now know the general nature of. It consists in melting the raw lead, permitting it slowly to cool to a certain point in a state of repose, when a larger or smaller mass of powdery octohedral crystals, a sort of lead sand, can be ladled out by perforated ladles or other means, drained of the intermixed fluid lead and put aside. The raw lead is thus separated into two portions—a greater one (these crystals) consisting of lead very poor indeed in silver; and a smaller fluid mass which is rich in silver, and has in it concentrated nearly all the precious metal that was in the whole raw mass.

The process is founded upon Pattinson having clearly recognized and taken practical advantage of facts previously observed and published by Berzelius and by Berthier, viz., that an alloy of lead with some definite proportion of silver melts at a lower temperature than pure lead. This definite alloy is found dissolved in pure lead when the raw lead of commerce is melted; hence, as the whole cools in repose, the lead itself, *gradatim*, "sets" first, *i.e.*, solid crystals begin to form and subside to the bottom of the pot, rejecting from their own little masses nearly all the silver before mixed or combined with them, so that on ladling out these crystals we ladle out constantly nearly pure lead, and so mechanically effect an almost perfect analysis of the raw silver lead, leaving only a small proportion in the bottom of the pot to be dealt with by cupellation in the way formerly practised upon the entire unwieldy mass. The phenomena are quite analogous thus to those by which in the freezing of sea water the salt remains in solution, and nearly fresh water is frozen. The result in money is to reduce to less than one-half the cost of desilverizing by the ancient method of cupellation, and the remelted up crystals are at once in the form of soft merchant pig lead, while the loss of lead upon the entire range of the process is much diminished.

We cannot go into the wide expanse of questions and conditions as to the best practice in Pattinsoning various pig leads, which have given rise to two main distinctions in the operations known in Germany as the "high" and the "low" methods, and which, without perhaps much influence on practice, Herr Stetefeld has sought to direct by mathematical investigation as to the division of the silver occurring between the crystals and the residual lead. Very ample details as to all this will be found in Mr. Crooke's edition of Kerls "Metallurgy," recently published.

We have to notice, however, some modifications of the apparatus which are employed abroad, and, it is affirmed, with advantage and economy.

The earlier apparatus employed by Pattinson himself, and still used in many places, consisted simply in two large open cast-iron lead pans (*chaudières conjuguées*), with a third small one, merely to keep the perforated ladles hot by immersion in lead. These two were employed alternately, one to receive the gathered out lead crystals, while from the other the enriched lead was being laded out and run into pigs, to be again melted, and the process repeated. But, on a more extensive scale of working, a whole range of such pans is employed, the number being decided by those of the distinct operations of removing crystals. In either case, however, the masses of *lead crumbs* or crystals are laded out by hand; and from the great specific gravity of lead, the heat, the somewhat awkward position of the workman over the pan for continuous exertion of the muscles, and the unwholesomeness that appertains to every operation of lead metallurgy, the labour of this is very severe. It is generally aided by the large perforated ladle being swung either from a swivel eye and suspending chain, admitting movement freely in all directions, but relieving some of the weight, or its being lifted by a simple form of crane, which, however, usually requires the attendance of a second man. In any case, as each ladleful weighs about 112 or 120 lbs., and about a ton an hour is thus lifted, the labour is oppressive.

M. Boudchen has contrived a system of apparatus by which a great part of the work of Pattinsoning is performed by power, and this is at work at Rouen, at Stolberg, and at Holzappel. The leading principle is that in place of lading out the crystals, these are kept in agitation, both to prevent their agglomeration and their entanglement of liquid rich lead, and the still fluid rich or silver lead is drawn off from the pan by an aperture at the bottom. The arrangement will be intelligible by the annexed figs. 1, 2, and 3. Fig. 1 is a general vertical section of the range or system of pans, of which there may be many in the one work. s and s are the chimney shafts. The pans are upon different levels, so as to run from one to the other, or out upon the floor level of the shop. In all three figures *a* is the cylindric crystallizing pan, and *b*, fig. 2, the ingot moulds into which the rich lead is run through the spouts at either side of *a*, which are provided with iron sluice stoppers. *c*, fig. 1 is the pan in which the raw pig lead is melted, and whence it runs into *a*; the latter pan being heated by the spare heat from the furnace of *c*. *d* represents a still higher pan, used as either a sort of magazine for *c*, which it supplies by the movable shoot, *f*, or from which the contents can be run into the ingot moulds, *b*, or to remelt together different masses of the poor lead. This upper pan is not indispensable, and, in fact, is not used at either Holzappel or Rouen. Where the pan, *d*, is used the capacity of *c* is $\frac{1}{3}$, and *d* $\frac{2}{3}$ of the pan *a*, but, as worked at Rouen, the pans, *c* and *a*, are of equal capacity. Fig. 2 is a vertical section of the apparatus of the pan, *a*, in a plane transverse to fig. 1, and fig. 3 is a like section in a vertical plane at right angles to the last.

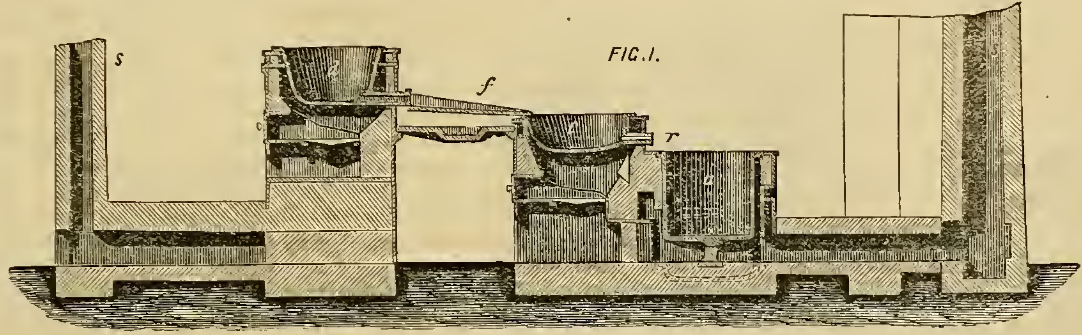


FIG. 1.

The pan is cylindrical, and contains two independent agitators or stirrers, driving (like brewers' mashing apparatus) through each other; the one being a system of blades or rakes attached to a rectangular frame driven by the outer or tubular shaft, and the other system of rakes like those of a pug mill nearly, driven by the central shaft, *l*, within the latter; and, as will be seen by the arrangement of the bevel gear in fig. 3, the two systems are driven reverse to each other. The pan is covered by a sliding up and down iron hood, with two tubes, *g g*, in connection with the chimney to take off lead fume.

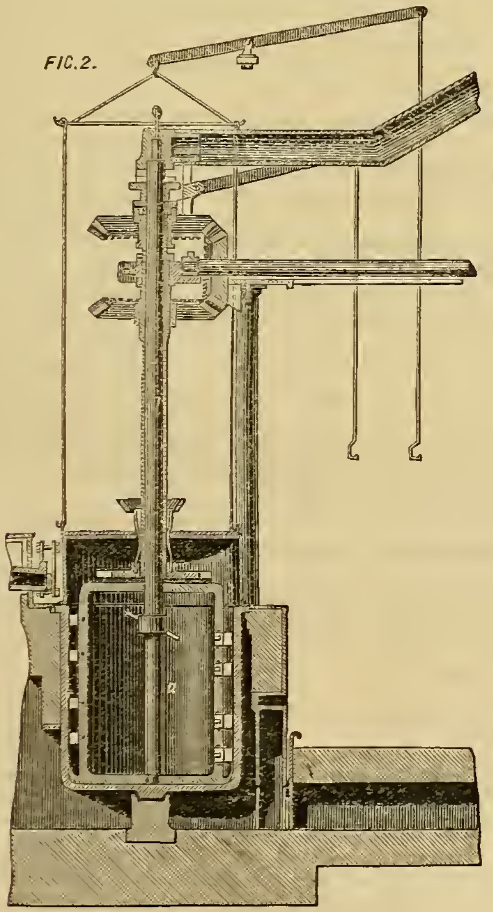


FIG. 2.

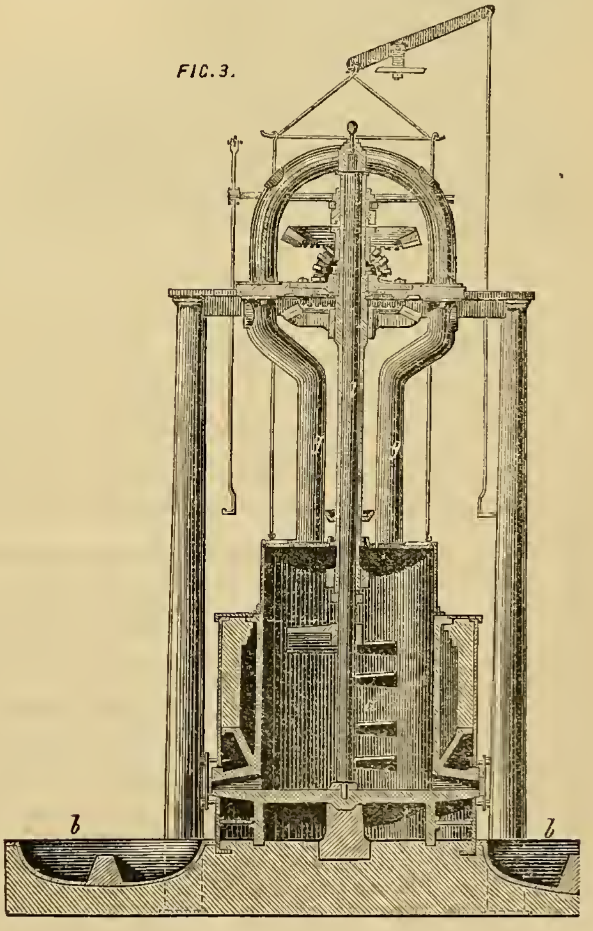
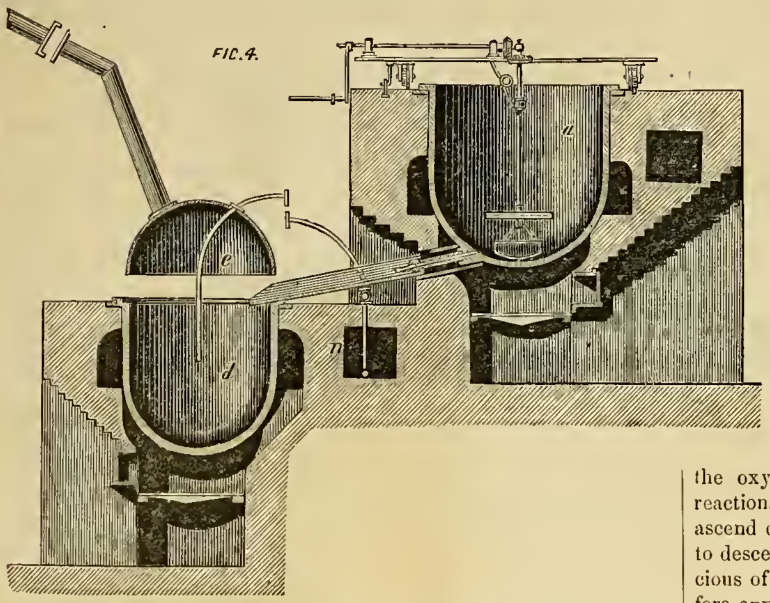


FIG. 3.

When the crystals first begin to form it needs but little power to keep the whole mass in agitation; but as these increase in volume the resistance rapidly augments, and at last, with a proportion of $\frac{2}{3}$ crystals and $\frac{1}{3}$ fluid lead, from five to six horse-power is only sufficient to keep up the motion until after the rich lead has been run off. The heat is then augmented under *a*, and the crystals themselves become liquid, and are in turn run out; or, as is the better practice, they are rendered fluid by running in upon them a fresh charge of liquid raw lead from the pan, *c*, continuing this until the crystals have reached the limit of their impoverishment.

M. Gruner states that with each 9-ton pan, and with 9 horse-power, from 110 to 120 tons of lead can be refined per month, the merchant pig, or impoverished lead, being brought to about 20 grammes of silver per ton, and the silver lead brought up to from 15 to 20,000 grammes per ton; the total consumpt of fuel, including that for power, reaching to 1 ton of coal for 4 of lead refined.

FIG. 4.



The cost of labour is reduced to about one-half, and the hand work that remains to be done is less laborious, more wholesome, and less subject to the caprice or neglect of the men, and there is less rich dross produced, because the covered pans enable the work to be conducted in great part in an atmosphere of lead vapour; against all this, however, is the greater capital invested, the excess on one set of pans being, probably, from £700 to £800. The total saving over the ordinary methods is stated to amount to about 18*s.* per ton of lead.

In the opinion of Gruner—though that is one apparently not shared by Kerl—every system of Pattinsoning is likely to be ultimately superseded by Parkes' method of refining—by alloying the crude lead with zinc. The process, of which the following is a sketch, is one of singular beauty at every stage. It is based upon the curious relations which lead and zinc, and zinc and silver, bear to each other when alloyed, and to the facilities with which zinc and silver are separable by divers methods:—

Karsten in 1842 had observed the reciprocal chemical actions of lead and zinc. He had ascertained that the two metals will not combine as alloys with each other better than do lead and copper. When the mixture of the two metals in a melted state is kept at rest, the zinc comes to the surface, retaining scarcely 2 per cent. of lead, whilst the lead goes to the bottom, taking away on its part a little of the zinc. The proportion is very often only ½ per cent.; this insignificant quantity, however, is sufficient to injure the malleability of the lead. The zinc seems unequally diffused, and produces thus solutions of continuity, and injures the tenacity of the lead when rolled into sheets.

Karsten, on applying the experiment to the raw leads of commerce at that time, ascertained that the zinc takes up the silver from the lead, and that after distilling away the zinc the precious metal had not been carried off. That able metallurgist, however, did not attach any great importance in this case to the new fact, and chiefly struck by the injurious effects which the zinc produces upon the soft lead, he did not think that this process could be usefully applied of separating the silver. Experiments were renewed in 1852, when it became known that the process had been applied in England, and that a patent with this object had been applied for by Mr. Parkes.

The experiments were undertaken at the works at Tarnowitz by M. Lange, under the superintendence of M. Karsten. At first they operated in a cast-iron pan, suitably heated. A ton of lead, containing 1400 grammes of silver, was mixed with 5 per cent. of zinc; the bath was stirred during two hours, and it was then left at rest for six hours. The zinc came to the surface, and after it had been solidified by the aspersion of water, it was taken off in the state of solid crusts or cakes. All the silver was found practically to be concentrated in the zinc, there being retained only 5 grammes of silver in the ton of lead. Another ton of lead, containing 936 grammes, was mixed with 2½ per cent. of zinc; the stirring lasted one hour, the repose four hours, and the disargentation was still found complete. When the quantity of zinc was reduced to ¾ per cent., then 56 grammes of silver remained in the ton of lead.

These trials proved that in order to maintain in a secure manner the silver residue down to 5 grammes in the ton, there are required, as other essays have shown, for raw lead containing from 1000 to 1400 grammes of silver per ton, 1½ per cent. of zinc, one hour of stirring, and four hours of repose. It has further been ascertained that the lead often takes up between ¾ and 1 per cent. of zinc, and that without regard to the total proportion of zinc mixed, so that 4, 5, or 20 per cent. gives the same final alloy. The temperature of fusion, also, is without any influence on the result. The stirring was produced in a mechanical manner, as in the Laveyssière's system above described. No great power is here required, as the two metals remain in a fluid state, and only oxidated drosses are produced. The zinc tending to oxidate most, the oxygen does not act upon the lead, and there is a defective reaction. This could be avoided in two different ways; the zinc might ascend drop by drop through the lead, or else the lead might be made to descend drop by drop through the zinc. The first, the more efficacious of the two, appeared to Karsten difficult to carry out. He therefore applied the second, which had already been used in the process by which cupreous materials had been unsilvered, by the method known as that of *imbibition.*

The raw lead was passed through an iron sieve into a pan which contained melted zinc. After three hours of rest, without any rake agitation, the lead was racked off through an iron pipe at the bottom of the pan; the disargentation was complete. Upon the same zinc was poured a fresh quantity of lead, and it was operated upon in a similar manner. The content in silver could thus be brought to 25 per cent., always with the use of the same zinc, and without reducing the completeness of the impoverishment of the lead. The lowest strata of the lead contained only ¼ per cent. of zinc, the highest ones about 1 per cent.

The argentiferous zinc which was thus obtained was then distilled in a Silesian muffle. The silver remained with the lead which was mixed with the zinc in the triple alloy. Operating upon 200 kilogs. of the triple alloy, there were 120 kilogs. of raw lead to 1½ per cent. of silver, which was treated by direct cupellation to isolate the silver. As regards the expense, it was found that this process of disargentation costs only one-third of that of the old-fashioned direct cupellation in mass. The latter costs 35 francs 50 cent. for the ton of raw lead, without including general expenses, but taking into account 4½ per cent. of loss upon the lead. Disargentation by zinc thus, costs 10 francs 50 cent., or about 12 francs, including the expense of the distillation of the zinc, the cupellation of the rich lead, and the maintenance of the implements and apparatus. The expenditure of the zinc process is composed, in reality, of the following details:—

	Francs.
Wages to workmen,	1·30
Coal,	3·00
5 Kilogs. of waste in the lead,	2 25
5 Kilogs. loss on the zinc,	1·85
7·50 grammes loss on the silver,	1·65
Total,	10·05

Notwithstanding this evident advantage, they did not venture in 1852 to adopt the new process at Tarnowitz. They feared not to be able to deprive the lead itself, in a convenient manner, of the small residual amount of zinc. They confined themselves to experiments for its purification by means of a prolonged remelting of the lead, with long repose. Karsten, however, in the end, did advise the practical use of zinc, and expressed his opinion that the lead could be purified, by means of oxidation, on the hearth of a reverberatory furnace. These previsions of Karsten have been realized. The zinc refining of the raw lead is applied at the present time, not only in England, but also in Germany and in France; and it is found easy to separate now, either by oxidation or by chlorinization, all the zinc from the disargentated or poor lead, so as to render it fit for commerce. Comparing the sum of 10·05 francs, or even of 12 francs, with the prime cost of the Pattinson process, it will be seen that the zinc refining has the advantage. The loss on the lead, which amounts to 2 per cent. in the Pattinsonizing, properly speaking, is in this case reduced to one-half, or to 1 per cent. If we add to that the advantage of less extensive works and of a much quicker mode of operating, we arrive at a reduction both of the capital invested in the establishment and the floating capital needed to carry it on.

This disargentation by zinc is in use in Wales, in Germany at the works at Mechernich, near Commorn, and at Braubach on the Rhine; in France at La Pise, and at the refining works of M.M. de Rothschild at Havre. At Braubach, in place of driving off the zinc from the silver by volatilization, as they do at Tarnowitz, and as is done in Wales, they separate it in a very ingenious way. From lead drosses or chimney fumes they obtain chloride of lead, by direct treatment with dilute hydrochloric acid, an educt of chemical works. This chloride of lead is agitated in a cast-iron pan, with the rich silver zinc at a low red heat; Chloride of zinc is formed, and the lead set free, which is then separated from the silver by cupellation. The poor lead again is deprived of its small content of zinc, by treating it in like manner with chloride of lead. The chloride of zinc is treated in reverberatory furnaces, in order to extract any remains of lead mechanically mixed with it. It would seem to us better practice to lixiviate and wash out the lead, and to concentrate the chloride of zinc, for which a market might be found as a vegetable preservative and disinfectant.

The apparatus by means of which this beautiful process is carried on in the refinery of Baron Rothschilds, at Havre, is due to the skill of M. Cordurie, and is represented in vertical section in fig. 4. *c* is a hood over the pan *d*, in which the zinc is oxidated by a jet of superheated steam, heated in the flue, *n*, through which the steam pipes pass; the flue is itself provided with a steam jet to carry off fume by its means into the chimney; *a* is the pan for making the alloy. The agitating apparatus, and for the application of the zinc, are seen in the centre of the alloying pan, and the arrangement by which the poor lead is drawn off at the bottom is evident.

The zinc as a flat cylindrical ingot is plunged into the bottom of the lead in fusion, and caused to revolve in it until fused and mixed. This is effected by the apparatus shown in the centre of the pan, *a*. The rich silver crusts on top, after repose, are skimmed off, and then heated, after their union into large masses, as already described, while the poor lead is deprived of its zinc here by steam oxidation, as described.

Having already, however, extended so much this notice, we cannot add many interesting and valuable details as to the variations in the treatment which are made at Havre, at Braubach, and at Tarnowitz, to suit various sorts of lead presented to them in commerce, some of which are very complicated alloys.

In conclusion, we ought to remark, however, that Gruner gives his own preference to the steam oxidation process for getting rid of the zinc, rather than to the treatment by chloride of lead, as being more efficacious, less unwholesome, and less costly.—Ed.

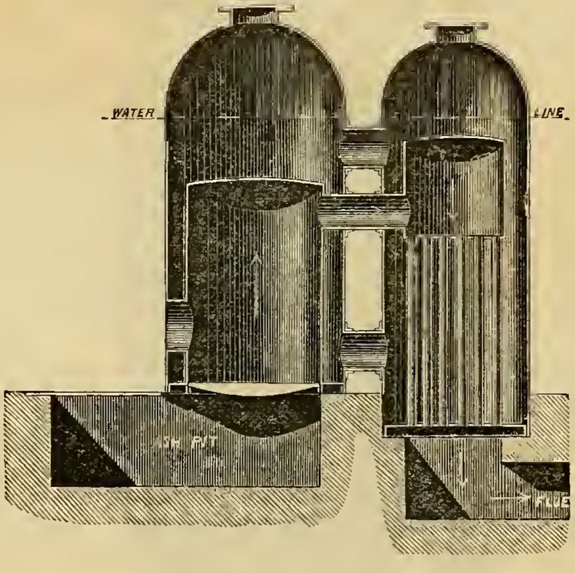
INDEPENDENT TUBULAR BOILERS.

The Seguin tube boiler applied to the early locomotives by the Stephensons, and proved capable of such rapid and efficient generation of steam, gave almost at once an impulse to the use of tubular boilers of one sort or other for land and fixed engine use, which, however, has not been followed out, nor has progressed as steadily as might have been wished.

As long ago as about 1836 Messrs. Mather, Dickson, & Co., of Liverpool, were amongst the first to adapt to fixed engines the locomotive boiler, pure and simple, but enlarged, and from the designs of Mr. John Grantham, C.E., the very large boilers, for that day, were constructed and fixed at Edgehill Station, for the supply of high-pressure steam to the fixed engine also constructed by them for working by rope traction the incline in the tunnel between there and Lime Street. These boilers worked with economy and satisfaction for several years; we believe no objection was ever made to them but that of their considerable first cost. Many years ago, also, Messrs. Rennie employed one or more engines in their works in London from a vertical boiler, consisting of a simple cylindric external shell, a drum fire-box inside, carrying above it a large number of vertical tubes, the gases from the whole of which were gathered into one central flue, which passed off directly from the top of the boiler. The water surface was necessarily below the top tube plate, and so a small length of the upper and cooler end of the tubes, and of the top tube plate, were exposed to contact with steam in place of water. This boiler, we were ourselves assured by the late Mr. George Rennie while examining it, had then for some time continued to give them steam at high pressure, with a consumption of mixed coal and coke equivalent to not more than 2½ lbs. per hour per indicated horse-power.

This form of fixed tube boiler, of great simplicity, and as great cheapness as any tube boiler perhaps is susceptible of, had even to a rather greater degree than the horizontal-tubed locomotive boiler the advantage of permitting easy repair. The misfortune of all fixed tube boilers, which, for land work, are required as one of their primary conditions to be worked for long periods and perhaps without a moment's cessation, is, that the surfaces of the tubes, whether these are exposed exteriorly or interiorly to the water contact, coat and fur over with earthy matter, deposited or collected, and concreted from the water at a rate that is injurious to them, though less so with boilers exposing broad, flat, or curved surfaces to the water. The small tube is practically at all temperatures so nearly the same diameter that scale formed does not easily crack off spontaneously, while it has a much better chance of doing so from broad surfaces, which are continually changing their shape with variations of pressure, and their dimensions with differences of temperature. Mere length in tube does not seem capable of letting it clear itself thus of scale. Besides hard accretional scale, most natural water deposits more or less loose mud or sediment. Now, the horizontal locomotive tube form of boiler may be so made for fixed or land use, that most of this shall keep away and deposit clear of the tubes. This advantage, however, is not secured by the simple vertical form of tube boiler above described, as constructed by Messrs. Rennie: for the loose sediment, as well as any that may detach itself from the tubes, falls down and lies amongst the tubes, on the lower tube plate, and gradually passes thence by ebullition and currents in the boiling water, down to the bottom of the water wards of the fire-box; and it is at all times an unhappy arrangement when the sediment tends to deposit finally about some of the hottest parts of the boiler plates.

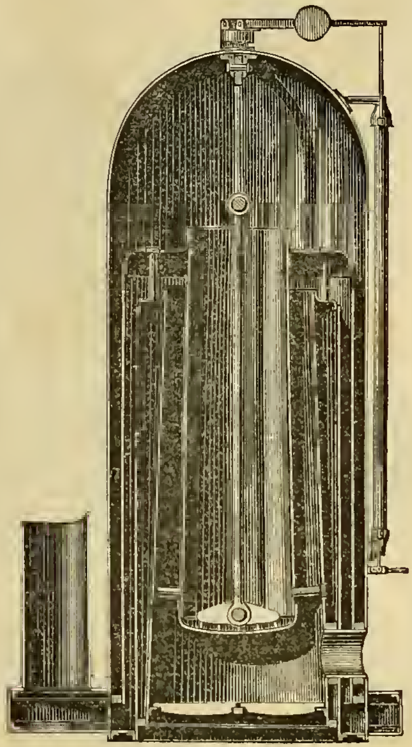
Fig. 1.



Another form of fixed tubular boiler, known as Inglis' in the north of England, and, we believe, the subject of a patent, was in use at the Elswick Works, near Newcastle, about 1863, and when we saw it, appeared to have been working in a very satisfactory, and we learned, as we should have expected, in an economical manner. A longitudinal vertical section of this boiler is shown in fig. 1. This boiler consists of two dome-topped cylindrical shells, of unequal diameter and height, connected together, above and below, by two cylindrical water flues, big enough for a middle-sized man to squeeze through. The larger cylinder contains the fire-box, and a smoke flue, rectangular in section, leading from the fire-box through the walls of both cylindrical shells, and into a cylindrical tube chamber in the centre of the smaller cylinder, from whence a fasciculus of vertical tubes descend to the lower end or tube plate of the same cylinder. The whole boiler sits in brickwork, the ash-pit in front of the fire door being covered with a perforated cast-iron foot-plate, and the course of the arrows in the figure indicate those of the gases on their way to the brick flue under the floor leading to the stalk.

Now most of the important conditions for tubular boilers are found here combined; every part, inside and outside, is as readily come-at-able as need be. There is ample circulation of the water, and a large surface both of fire-boxes and of tubes can be readily secured and well applied; moreover, except as to the tubes themselves, scale has as good a chance of detaching itself here as in any other boiler of broad plates; there is ample room for the deposit of sediment, and by mud-hole doors (not shown in the figure, because their position is partly matter of special convenience) can be made, so easily and so accessibly, that it can be periodically cleared out, if not removed even more frequently by mud cocks. It is also all pretty simple boiler-makers' work, both to make and to repair, and changes of dimension from hot to cold act systematically upon it, and tend little to rack its frame. It is, however, not a cheap boiler. When employed for uninterrupted service, the best mode of feeding it with water—and, indeed, this applies to every form of fixed tubular or lamellar boiler—would be to pass the feed water into a heating vessel of cylindrical form, placed in the horizontal flue, and so arranged that the sediment deposited in that could not enter the boiler, and should be easily removed from the vessel while the boiler continued at work.

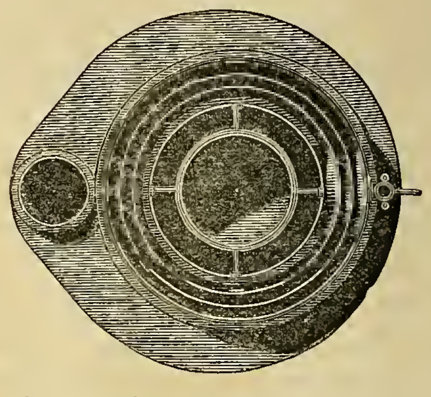
Fig. 2.



A decided advance could be made thus upon the construction of multispaced fixed boilers, if we can abandon or reduce to the smallest extent tubes, and construct the boiler upon the lamellar principle instead; for then we shall substitute broad surfaces, which tend to keep clear from scale (under usual conditions), for small diametered tubes, which tend to clothe themselves with scale. This has been attempted in a multitude of forms—with flat water wards of one shape or another, as in Mr. Lamb's marine boilers; but such surfaces do not readily admit of the requisite strength for high-pressure steam, however admirably they may work under the conditions and moderate pressure of marine boilers.

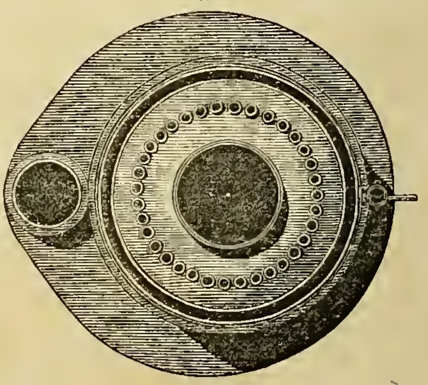
The requisite conditions have been recently very well fulfilled, however, in the boiler patented by Messrs. Allibon & Manbre, the first named inventor, Mr. George Allibon, being of the Rosherville Ironworks, and anteriorly manager of the Millwall Ironworks, and since of the Worcester Engine-works. Fig. 2 is a vertical section of this boiler, the construction of which is so simple, that it will be understood almost without description by any one acquainted practically with boiler work. It consists of a vertical cylindrical shell (which may be of greater or less height to suit circumstances), containing four other shells nearly cylindrical, and so united that each alternate annular space is filled with water, while the other alternate ones afford, in a direction of movement up or down, passage for the gases of combustion of the fire, the fire-box for which is in the bottom of the cylindrical and internal shell, on their way to the chimney. Fig. 3 shows in horizontal section these several annular spaces, and fig. 4 the ring of short tubes, by means of which water communication is maintained between the interior annular water space and the water above the top tube plate.

Fig. 3.



The advantages secured by this boiler are pretty evident; it is very simple in workmanship, and admits of great strength. Two of the cylindrical internal shells are exposed to compression on their convex surfaces by the steam or water, but these can be easily and well stayed up to those against the interior or concave surfaces of which the pressure acts. The parts are easily pulled out one from the other for examination or repair, and with extremely little boiler work, or unmaking and remaking of joints. There will be but little fast scale, but the loose deposits will require to be passed off at intervals with regularity. In our own judgment the four short tubes of water communication between the central cylinder would be best put somewhat higher up, and a sediment box of parallel contour with the rounded bottom of this cylinder placed within it, and suspended from above. If judiciously placed, and the feed water (from an external heater always) properly introduced and led first into that suspended vessel, we think almost all sediment would take place therein, and all the rest of the boiler remain nearly free. Two conjugate boilers of this sort obviously might be made, and fired from one fire-box in one of them, something as in Inglis' boiler, and probably with advantage as to consumption of fuel. This form of boiler might be made very suitably applicable to the use of liquid fuel, assuming, what has not yet been properly done, that that fuel is burnt as vapour, mixed with its equivalent of atmospheric air, previously heated to a sufficient temperature by the waste or other heat.

Fig. 4.



We entertain but little doubt that these boilers will prove safe, economical in work, and, at the very least, as much so in repair, as any known form of multispaced boiler. In respect to its central cylinder this boiler bears some little similitude to Mr. Thompson's "pot boiler," exhibited in 1867 at Paris; none whatever, however, in its general design, which is greatly superior to that of the pot boiler.

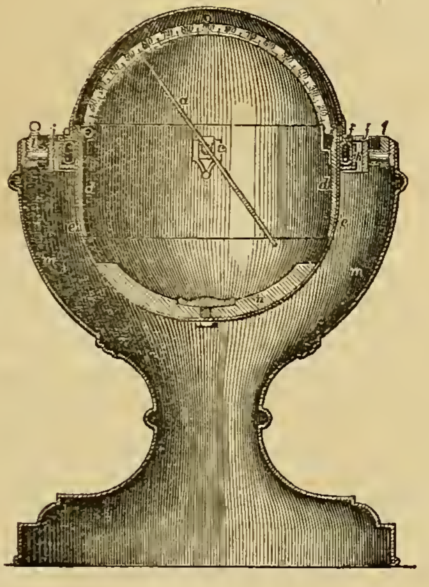
A multiwarded (flat tubular warded) boiler was exhibited, by drawings only, in the Austrian division, also at Paris, presenting immense heating surface for a given bulk. As shown, we do not think any practical engineer would repose much confidence in it, but some hints might be taken from it, and worked into better form. It has been figured in, we believe, the Austrian government reports.—Ed.

CAMERON'S PATENT COMPASS.

This compass has been specially designed and constructed for the purpose of indicating the ship's true course, independently of terrestrial or celestial observations—an advantage which will at once be apparent to those versed in matters of shipbuilding or navigation.

The disc or card of the compass is manufactured from a sheet of steel, rolled, hardened, and magnetized north and south, so that the reed of the steel is parallel with the poles. By this means the atoms composing the disc arrange themselves in a more perfect way for receiving the magnetical influences or current.

Fig. 1.



This disc or card is suspended in a horizontal direction, and when in traverse position to the magnetic meridian, the instant it assumes the greatest dip, it is thus indicating the N. S. E. W., and at the same time indicating the ship's true course on the divided circle that cuts the line of the ship's head. To verify this observation, if the compass be moved until the disc assumes an upright or *perpendicular position* (this is the method most to be approved of in finding the various courses), it is then parallel with the magnetic meridian, and again indicates N. S. E. W., the point on the circle which cuts the line of the ship's head is the true course. The correctness of this observation may be further determined. Attached to the bissel which holds the glass is a small magnet, which is movable round the compass. When the steel disc is made to indicate N. and S.—that is, when upright—if the magnet be now moved to E. or W., the disc will be attracted a few degrees E. or W. The mean of this deflection would be the true North, and the point which cuts the line of the ship's head would be the true course. By the same means we can discover the amount of the disturbing influence that may be acting on the compass.

Fig. 2.

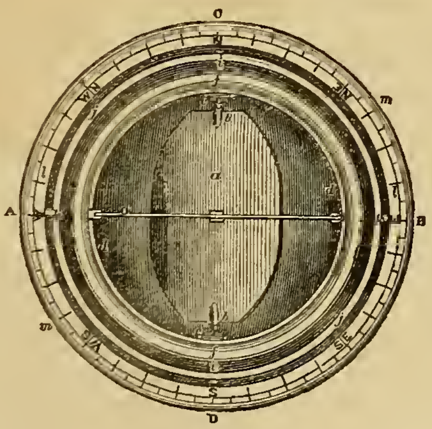
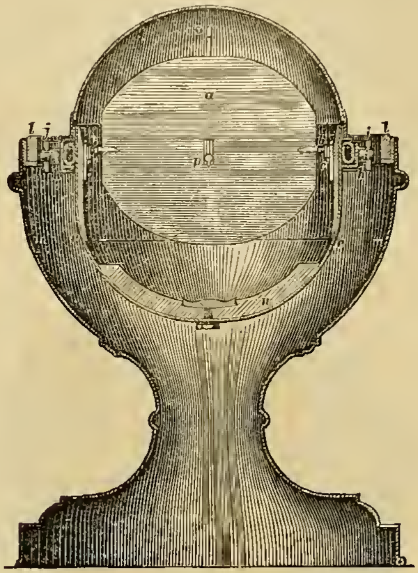
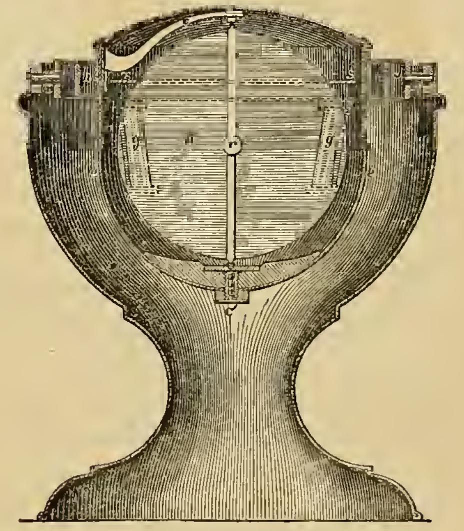


Fig. 3.



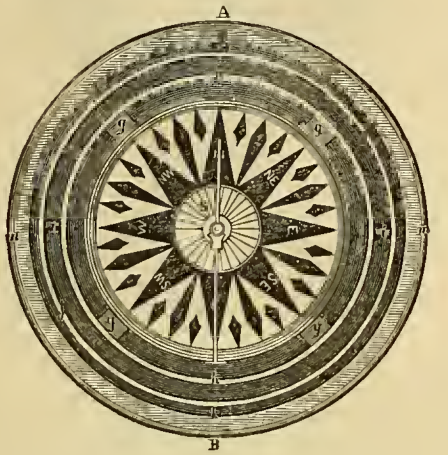
To insure the true indication in southern latitudes, there is fixed to the centre of the disc a screw which carries a small brass ball, which may be elevated or depressed when adjusting the card for correct indication. Apart from this adjustment the true course may be equally determined. Suppose the disc, when traversed with magnetic meridian, indicates a dip of 70° W. and 76° E., the complement of the angles 70° and 76° would be = to 34°, the half of which would be 17°, which added to 70° would give 87°, thus giving 3° W. for the angle of equilibrium. If the disc be now turned to indicate 90°, suppose it to indicate 88° W. and 82° E., the true line of equilibrium would be 3° E., whatever point cuts the line of the ship's head is the true course. From this it will be evident that the ship's true course can be observed independent of celestial or terrestrial observations. This form is what may be called the *Standard Compass.*

Fig. 4.



The construction of this compass will be more clearly understood from the following description and accompanying engravings, of which fig. 1 is a vertical section on the line, A B, of the plan, fig. 2; and fig. 3 is a section on the line, C D, fig. 2. On these figures similar parts are indicated by corresponding letters of reference. The compass shown in figs. 1 and 2 may be described as a disc-dipping compass, whereby the true bearings of the ship's course may be found independent of celestial or terrestrial observations. To effect this a sheet or disc of steel, *a*, is employed suspended in a horizontal direction on pivots, *b b*. This sheet or disc is magnetized north and south, so that the reed of the steel is parallel with the poles; by this means the magnetic atoms in the disc arrange themselves in a more perfect way for receiving the magnetic influences or currents. The pivots, *b b*, are supported in suitable bearings, *c*, fixed to a copper ring, *d*, fitted inside of the bowl, *e*. The bowl, *e*, is suspended by a rim or flanched ring, *f*, which is fixed round its mouth, and rests upon an india-rubber tube, *g*, which is carried in the gimbal ring, *h*; by this means an elastic cushion is provided for the compass, and prevents its undue disturbance from concussion or the rolling or pitching of the ship, *i i*. Figs. 2 and 3 are pivots on which the gimbal ring, *h*, swings inside of the gimbal ring, *j*, which is swung on pivots, *k*, fixed in the movable graduated ring, *l*, which is supported on the stand, *m*. The bowl, *e*, is weighted with lead, as shown at *n*, figs. 1 and 2, so as to make the gimbal rings answer any change of position promptly, and thus maintain the axes or pivots, *b b*, in a horizontal position. A semicircular graduated index, *o*, is placed over the magnetic disc, *a*, to indicate the angle or dip.

Fig. 5.



From practical observations by this compass, the true course may be as clearly indicated in the saloon or commander's room as in the most favourable place of the ship, so that the courses of an iron ship will be as easily steered as those constructed of wood.

In the *Steering Compass* the card is attached to the disc, which is suspended perpendicular, so that the poles of the disc are in a horizontal direction. In this arrangement the steel disc is substituted in place of the needles usually attached to the compass card. This disc being large compared to the needles, its magnetism being so much more powerful, keeps the card to its position in the magnetic meridian, and by this means the ship's true course is indicated.

Fig. 4 of the engravings is a vertical section on the line A B, on fig. 5, which is a plan of a steering compass; in this arrangement the disc, *a*, is held in a strap, *q*, by a pinching screw, *r*, and is permanently situated in a vertical position, supported by the pivots, *b b*, carried in suitable bearings in the bracket, *c*, and the screw *c'*. The indicating card, *s*, is fixed in a horizontal position on the disc, *a*, as shown; the bowl, *e*, is suspended by metallic springs, *g*, from the gimbal ring, *h*, which is swung in the manner hereinbefore described in reference to figs. 1 and 2. The action of the compass is the same as the ordinary needle-steering compass in present use.

OCEAN STEAMERS.

By George Allibon, Esq., C.E.

The increasing demand for ocean steamers to meet the exigencies of commerce, and the conditions which must be satisfied to make their employment remunerative, have not only occupied the serious attention of the shipping interest, but have exercised the utmost ingenuity and skill of the most eminent naval architects and marine engineers. A subject of such magnitude, and of such national and commercial importance, could not be discussed in this country without attracting to its consideration many of the most acute and practical minds, thoroughly conversant with the necessary details, and capable of utilizing all the information to be derived from the theory and practice of steam navigation as at present understood.

To enter fully on so wide a field of investigation is not my present purpose. The ground has been already ably occupied, and my experience forbids me advocating any theoretical novelty until I am prepared to support my views by reference to experiments, conducted on so large a scale as to bear the stamp of incontrovertible testimony. For the present I propose to state concisely the conditions required of marine engines, and the kind of machinery which appears to me most efficient for that end. Many years' employment as a practical engineer in some of the largest works in the kingdom have convinced me that no mere experiment nor trial trip is of the smallest value in determining the merits of any principle or improvement in the construction of engines for ocean-going steamers. I shall, therefore, substantiate what I advance by reference to the performances of certain well-known vessels of high character on *long sea* voyages, selected with a view to afford a fair comparison, irrespective of my personal opinions or convictions on the subject.

In the present instance I intend to confine my attention to the construction of engines for mercantile vessels, as conditions very similar must overrule the construction of engines for ships of war. It may be observed, however, in passing, that economy in the consumption of fuel is demanded by both, in the one case from consideration of expense, in the other of efficiency. Simplicity of construction is no less necessary. Viewed apart from the question of first cost, which is a matter of trifling importance in the royal navy, the simpler the engines, so that they perform the allotted work, the better they are adapted to the vicissitudes of weather and of war on distant stations.

The most obvious and the most important desiderata in the marine engine are:—

1. Economy in consumption of fuel.
2. Simplicity of construction.
3. Lightness and compactness.
4. Power of working for long periods without adjustment or repair.
5. Cheapness in construction.

1.—In considering these points, I shall endeavour to avoid the technicalities which flourish in such profusion in connection with scientific subjects, and which tend to confuse rather than to enlighten the non-professional public. To exert a certain force of commensurable character in such a manner as to give rotatory motion to a paddle or screw, is the end to be accomplished by all marine engines. The business of the marine engineer is to supply the motive power required, and the amount of his success is, *ceteris paribus*, inversely as the cost of that power.

The great expense of coaling at foreign stations, and the incidental delays on long voyages for coaling purposes, have justly contributed to place a high value on engines whose consumption of fuel is small in proportion to their indicated horse-power. The encroachment of coal bunkers on the space available for cargo, is so important a consideration as still further to enhance the value of engines requiring but a small supply of fuel. The efforts of the most able and intelligent engineers have, accordingly, been directed to the construction of engines which shall work at a high indicated horse-power on a small consumption of coal. The modern introductions, such as double cylinders, superheaters, &c., are the methods which have been proposed and applied for this purpose. That, in many instances, these alterations in the ordinary marine engines have been introduced with most satisfactory results is beyond dispute, but I think it can be shown that the great increase they involve in the first cost of construction, the complexity of their arrangements, and the trouble and expense of repairs, will always prove serious obstacles to their general adoption.

2.—Simplicity of construction is not only a valuable property in all machines for the production and distribution of power, but is of unexceptional utility in a marine engine. In long sea voyages the action of the propelling power is constant, extending, perhaps, over a period of several weeks. The liability to derangement in a complex engine subjected to so severe a trial is obvious. The difficulties inseparable from the readjustment of damaged machinery are augmented in proportion as the parts cease to be simple, and the necessary repairs of such complex engines are not readily executed at sea or abroad. The first cost of such engines must necessarily be greater than the first cost of engines of simpler construction. The friction must be greater, the wear and tear greater, and the dead weight in the vessel greater. These and many other objections, equally cogent, can be urged against complex marine engines; but of late the pressure upon engineers to reduce the coal account in ocean steamers has led them in many instances to abandon all other considerations for this single end. In some isolated cases the desired result has been obtained; but at what price? The first cost and the expense of repairs of such supposed economical engines will not furnish a very satisfactory reply.

3.—Lightness and compactness are relative terms, and must be understood within the limits of strength and utility. Of two engines identical in power, in cost, and in durability, that which is the simplest is usually the lightest, and occupies the least space. It will be readily conceded that, under such circumstances, the lightest and the most compact would be most suitable for marine purposes.

4.—A sea voyage of three or four weeks' duration affords a satisfactory test of the capabilities of a marine engine. Under such circumstances, the smallest mechanical inaccuracy becomes magnified, and leads inevitably to disarrangement, and ultimately to a break down. The excellent quality of the materials employed, and the superior skill brought to bear by the leading engineering firms, in the construction of engines for ocean-going steamers, have hitherto neutralized, to a great extent, the defects inherent in complicated constructions; but this partial success can only be achieved at a proportionate expense. Exceptional mechanical skill commands exceptional remuneration, and must always represent a constant difference in the first cost of machinery. To vessels employed in the passenger trade or in connection with the Mail contracts, it is not too much to estimate the power of performing their voyages with undeviating punctuality as of paramount importance. Their efficiency in this respect will depend mainly upon the capability of their engines to continue working over protracted periods at a certain minimum speed. Even in engines of the simplest construction, it is impossible to insure the constant perfect action of all the parts. Increase the number of parts, and the chance of mishap must manifestly increase proportionately. If it be admitted that the success of ocean steamers principally depends upon the capacity of their machinery, and that the efficiency of the machinery depends upon the accurate working of all its parts, it seems obvious that the fewer those parts, the less likely are they to become deranged, and the better adapted for the service of such vessels.

5.—The element of cheapness in the first cost of an engine for marine purposes is of still greater importance than in other productions of skilled labour. The constant wear and the unequal and severe strains to which marine engines are necessarily exposed render the depreciation excessive. Their profitable employment must therefore depend not only on the capital sunk at first in their production, but on the heavy annual percentage of depreciation which this class of stock involves. However great the consumption of coal by an engine, the limit of expense can be readily ascertained. If by any complex modification in the machinery this expense can be reduced, a certain advantage will appear to be obtained. Before concluding that this advantage is not illusory, it will be necessary to compare the difference in first cost of the engines, and the annual charges for depreciation. When these are taken in connection with their relative efficiency, a balance favourable to either system may be found. But if the simpler engine perform equal work on an equal consumption of fuel, it requires no argument to prove its superiority.

Extensive practical experience in the designing and construction of marine engines, with the constant view of satisfying the conditions I have thus briefly adverted to, has convinced me that the advantages gained by the modifications of double cylinders, superheaters, &c., have been to a great extent overrated. These costly accessories not only greatly enhance the first expense of the engines, and involve a heavy annual charge in the shape of depreciation, but, from their complicated construction, threaten at all times to impair their efficiency on long voyages. Although this opinion has been arrived at from results obtained in certain engines of my design, the experiments had been too limited, and the voyages too short, to justify me in concluding that my opinion was well founded. A fortunate opportunity, however, presented itself of completely testing the soundness of my conclusions.

During my engagement as resident engineer of the Millwall Iron Company, I was employed to design engines of 350 horse-power for the screw steamer *Kaikoura*, built by Mr. Lungley for the Panama, New Zealand, and Australian Royal Mail Company.

Her destination was the New Mail Contract Line between Wellington and Panama, a distance of more than 6000 miles. The engines I designed were of the simplest construction, cutting off at one-eighth of the stroke, and furnished with surface condensers. On her official trial trip, her expenditure of coal was 2¼ lbs., nearly, per indicated horse-power per hour. This excellent result fully justified my anticipations; but to complete success there was still wanting the criterion of a long voyage. The subsequent performance of the *Kaikoura* on the pioneer voyage from Sydney to Panama, as attested by her log-book, has proved equally satisfactory. In a run of 648½ hours under steam, the *Kaikoura* traversed 6150 miles, at an average speed of nearly 10 knots per hour. Although supplied with colonial coal, which, for steam purposes, is greatly inferior to that of our own mines, her consumption during this long voyage scarcely exceeded 3 lbs. of coal per indicated horse-power per hour. The engineer reports that the working of her engines was in every respect satisfactory. The *Kaikoura* has since performed the voyage repeatedly without accident or derangement. Her success may, therefore, be received as an established fact, and, I think, may fairly be adduced in support of my design as a proof-test of no ordinary character. No other steam ships in the world perform so long a voyage without interruption, and, with the exception of the Cunard line, no vessels on long sea voyages have attained a higher average rate of speed. This is the more remarkable from the fact that the "lines" of the *Kaikoura* are not such as are calculated to insure speed. The *Ruahine*, a vessel of similar dimensions, built by Mr. Dudgeon for the same company, accomplishes an equal speed with 160 indicated horse-power less than the *Kaikoura*.

Premising that the *Kaikoura* is not, in many respects, a favourable example of vessel to do even justice to the efforts of a marine engineer, I shall compare her performances with those of a vessel in every respect her antithesis. The *Moultan*, a magnificent screw-steamer, built for the Peninsular and Oriental Company, and engined with double cylinders, is probably the most perfect vessel in the splendid steam fleet of that company. It is scarcely exaggeration to say that she was built regardless of expense. Engine-makers were required to direct their chief attention to the consideration of economy in the consumption of fuel. Under such favourable conditions, and unrestrained by those parsimonious considerations which so often cramp the engineer, the eminent firms that were employed to construct the *Moultan* turned out a piece of workmanship in every way worthy of their own fame, and the high reputation of their employers. As regards speed, and small consumption of fuel, she stands pre-eminent even among other vessels of the same Company that have been built with a view to similar results. In comparing the *Moultan* with the *Kaikoura*, I am taking the *best* of a high class of vessels, furnished with engines 30 per cent. more costly, supplied with coal of very superior quality, and employed in voyages of shorter duration. If, under such conditions, the *Kaikoura* will bear the comparative test, I think I may fairly claim recognition of my views.

Name of Ship.	Nominal horse-power.	Consumption of coal in lbs. per indicated horse-power per hour.	Average speed in knots per hour.	Number of hours under steam.
Moultan, . .	500	2·9	9·86	552
Kaikoura, . .	350	3·1	9·97	648 5

If, in the above consumption of fuel, due allowance be made for the inferiority of the coal supplied to the *Kaikoura*, the comparison will be, at all points, highly favourable to that vessel. As the other vessels in the Peninsular and Oriental Company are inferior to the *Moultan* as regards speed and consumption of fuel, it is unnecessary to multiply instances from among the steamers of that company.

Subjoined is a list, showing the comparative merits of five vessels belonging to the fleet of the West India Mail Company. In all of these the consumption of fuel in proportion to the indicated horse-power is largely in excess of the *Moultan* and *Kaikoura.*

Name of Ship.	Nominal horse-power.	Consumption of coal in lbs. per indicated horse-power per hour.	Average speed in knots per hour.
Douro,	500	3·55	10·37
Rhone,	500	3·36	8 75
Eider,	310	3 13	8·03
Tasmania,	744	3 74	11·29
Oneida,	472	3·91	10 70

Hundreds of examples might be instanced still more favourable to the *Kaikoura,* but I have confined my attention to the ships of the two great mail-contract companies, as, owing to the length of their voyages and local circumstances, they have, perhaps, more than most other companies, endeavoured to solve the question of a high average rate of speed, in combination with a small consumption of fuel.

The complete success of the *Kaikoura* has enabled me still further to improve on the design of her engines; and although it is impossible to say how far the modifications I propose may be classed as improvements before being submitted to the test of a sea voyage, I have good reason for believing that their simplicity and utility will sanction their adoption.

In drawing attention to their comparative results, so far as the engines are concerned, of the foregoing vessels, I by no means wish it to be understood that I consider those vessels failures. On the contrary, I think that in many respects they admirably fulfil the conditions they were required to accomplish. But my conviction is strong, that in endeavouring to reduce the coal bill, we have hastened into the opposite extreme, and have so far augmented the first cost of the engines, and the annual outlay for depreciation (which of course varies as the first cost), that we shall shortly arrive at a point where the complex character of our machinery will jeopardize the efficiency of our ocean steamers. From the experience acquired in the construction of engines representing many thousands of horse-power, I may confidently affirm that all the practical results in economizing fuel that have ever been obtained by any marine engine, however complex, are to be obtained by the simple form of engines designed for the *Kaikoura.* These, with a few modifications, would not only prove more economical in the consumption of fuel, but at least 30 per cent. cheaper in the first cost, than any equally efficient engines constructed on the double cylinder principle. In every other respect they satisfy the conditions which I advanced as those which should regulate all marine engines.

At the Institution of Naval Architects in 1866, Mr. Bowman, the superintendent of the Panama, New Zealand, and Australian Royal Mail Company, whose duty it had been to represent the company on the trial trip in the Channel, said—"The engines of the *Kaikoura* are the most perfect specimens of engines, with expansion taking place in the single cylinder, that I have met."

If further evidence were required of the continued success of the *Kaikoura,* it would be amply furnished by articles in the journals of Australia and New Zealand. At this point, I think, I may safely leave the subject. I have endeavoured to show that it is possible to effect a saving of coal equal to that obtained by more complicated and costly engines, and that at a first cost considerably less.*

THE NEW IRONWORKS AT KIRKLESS HALL, WIGAN.

Recently a number of gentlemen interested in the iron trade assembled at the Kirkless Hall Works of the Wigan Coal and Iron Company, for the purpose of witnessing the setting to work of three compound blast engines which have been erected by Messrs. Nasmyth, Wilson, & Co., of Patricroft, in connection with other extensive enlargements of the premises and machinery. We proceed to give a description of the new works.

The new furnaces and engine-house have for many months been conspicuous objects in the mass of buildings which form the company's establishment at Kirkless; but to realize the character of the recent additions a closer inspection is necessary, and it is difficult to convey in words a true idea of the extent and completeness of the company's plant for the manufacture of iron. There are five old furnaces 65 feet high, and to these three 80 feet high have been added. It is proposed to construct two others, so that when all are built there will be a range of ten furnaces; and it is to supply these with the necessary amount of air that the engines have been erected. The engine-house is rather a handsome structure, having a tower 100 feet high projecting from the centre of the front, and it stands at the end of the row of furnaces, to which the blast is conveyed in a tube of wrought iron, 7 feet in diameter at the engine-house end, and lessening as it nears the further extremity of the range. The blast is delivered into the furnace at a pressure of about 4 lbs. to the square inch. Before it enters the furnaces, which are each provided with six twyers, the blast passes through ovens heated so as to raise its temperature to from 800 to 1000 degrees Fahrenheit. The furnaces have closed tops, and thus the gas generated is prevented escaping into the atmosphere. It is conveyed in a tube 8 feet in diameter to the heaters, four of which are connected with each furnace, and to the boilers, so that no solid fuel is used, gas being entirely substituted both for raising the steam and heating the blast. In front of the engine-house stand ten double-flued boilers of very large dimensions.

The engine-house is entered from a flight of steps leading into the tower, which contains a circular staircase running the whole height of the building. The main structure is about 84 feet long, 56 feet wide, and 70 feet high. It consists of three stages, and two of those are galleries, to which access is gained from the staircase in the tower, leaving a large open space in the centre. The engines work high and low pressure, and on the ground floor are placed the steam cylinders, six in number; the high pressure cylinders being 45 inches in diameter, while the low are 66. On the second story is the necessary space for the working of the engines, each having a stroke of 12 feet. From this balcony also the engines are worked, but there is a duplicate apparatus on the story below. On the third floor stand the air cylinders, which are each 100 inches in diameter. The engines are worked in pairs, the high pressure being connected with the low by means of beams 36 feet from centre to centre. Both cylinders are worked by the same valve gear, invented and patented by Mr. Robert Wilson. The advantage of the new arrangement is that the engines work so perfectly smooth, that there is no sensible vibration when the tripper comes in contact with the valve lever, the construction being the reverse of the old hand-gear and the tripper motion. A balcony is placed at the top of the air cylinders, so that access may easily be obtained to that part of the apparatus; and there is also a large travelling crane near the roof of the building, by means of which any portion of the machinery can be removed for repairs if necessary. The engines are finished in a very beautiful manner, and the building throughout, which is well lighted with large windows at the ends and sides, is decorated very tastefully.

The air to supply the blast is conveyed into the engine-house from a tower at a short distance by means of an underground tunnel. The water for the twyers and engines is obtained from a high level reservoir, and after doing its work it flows into the low level lodge, and is pumped back into the high level by one of Gwynne's centrifugal pumps.

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* We have enabled Mr. Allibon, as being a competent man and entitled to such a position, here to state his own views. We do not dispute his facts here, nor propose to impugn his conclusions generally, in which, to some extent, we agree. We must not therefore, however, be understood as accepting all: for all that Mr. Allibon has brought forward does not, in our judgment, by any means exhaust the question of the relative advantages and disadvantages of single or double cylindered marine engines working expansively. We happen to have had occasion to examine, with more than usual advantages, the magnificent *and simple* double-cylindered engines constructed by Messrs. Humphrys & Tennant, in the late Mr. Humphrys' time, for the P. and O. Company, and do not hesitate to say, that they appear to us to present in several respects, as engines for heavy ocean-going ships, advantages over any single-cylindered engines under like amounts of expansion. In such ships mere cheapness of engines should be a secondary consideration; and as to complication, in all marine or other engines, it may be real or only apparent. If engines can be readily handled, kept clean and in order, and reparable at sea—so far as any marine engine is so—their complication is only apparent. All who really comprehend the laws of expansion will admit that it can be conducted as economically, *quo ad* fuel, in single as in double cylinders. But to illustrate one only amongst the various subsidiary but important questions, that, besides this, go to make up the choice:—It is also true that with double cylinders the effort upon the crank is more uniform all round than with equal expansion in a single cylinder. Now, wrenching asunder main shafts is one of the most formidable evils, and amongst the most costly, that beset ocean steam-ship engines: main shafts were broken in the P. and O. fleet representing £20,000 or £30,000 in loss during a very few years, by their own return (see Proc. Ins. Civ. Engineers) obtained from the secretary. But in the single cylinder the maximum resistance through stroke of the sea in foul weather may just coincide with the point of maximum piston strain urging round the crank of one or other of the engines. We need not draw the inference; it is obvious.—Ed.

The hour fixed for starting the engines was one o'clock in the afternoon, and at that time there had assembled a large number of gentlemen. Shortly after the time appointed No. 1 engine commenced work; after it had been in operation a short time it was stopped, and No. 2 was started; and subsequently Nos. 2 and 3 were started together for permanent work.

ON THE DISPOSAL OF THE SEWAGE OF GLASGOW.

(*Continued from page* 304.)

"Sewage, applied at the rate of 1100 tons per acre, produced over 50 tons of mangold wurzel, while sewage applied to grass land at the rate of of 5400 tons per acre produced only 55 tons of grass, even after the allowances and corrections made by Mr. Morton. This quantity of sewage would have produced 250 tons of mangold wurzel, if it had produced results equal to the 1100 tons which were applied.

"Thus, then, it is evident that the land affords the means of purification, and that the process will be attended with highly beneficial results to those who undertake it.

"The next question is how much land will be required. The results at Croydon and at Barking have been produced by the application of from 5000 to 6000 tons of sewage per acre, a quantity equal to 100 persons to every acre, where the sewage amounts to 30 gallons per head per day. In Glasgow, however, the sewage, as we have seen, amounts to 70 gallons per head per day; and at present, owing to the unfortunate illness of our colleague, Dr. Anderson, we are not able to say what its value is as compared with London sewage, where the quantity is not half as much.

"It has been suggested that the value of sewage should be estimated by the number of persons, without reference to the greater or lesser dilution of the sewage itself. This, however, can scarcely be a correct mode of estimating its value, as water alone, without any of the fertilizing elements imparted to it by sewage, would very largely promote the growth of plants and increase the produce of the land, and, therefore, the 70 gallons per head of Glasgow sewage may reasonably be expected to possess a greater fertilizing power than 30 gallons per head of the sewage of London; for there is evidence to show that sewage of unusual strength does not produce as good a result as when it comes in a weaker state upon the land. If 5000 tons only be poured upon each acre in a year, the extent of land required for the present population of Glasgow, not including either Rutherglen, Pollokshaws, Renfrew, Paisley, or Johnstone, would be 12,000 acres. If it be measured by persons at the rate of 100 persons for every acre, which is the experience of London and Croydon, 5000 acres only would be required. Much also depends on the character of the soil, and probably a quantity between these extremes, say 8000 or 9000 acres, would be the proper area of land, if it could wholly be laid down in grass. It may, we think, be fairly assumed, that it would be impossible profitably to dispose of so large a quantity of grass as would be produced by this area, if wholly devoted to that crop. It has been conclusively shown that sewage is suitable, not only for grass, but for other crops, and that all cereals, as well as root crops, are increased in bulk by its application. The quantity, however, which these crops will take, is much less than that which will be taken by grass; and if, therefore, 8000 or 9000 acres are too many to be laid down exclusively for grass, a still larger area will be required if the sewage is applied to cereal and root crops.

"The total area of land within the valley of the Clyde, under a contour of 50 feet above Ordnance datum, suitable for the reception of the sewage, is about 9500 acres, of which 1500 acres are upon the north, and the remainder upon the south bank of the river, below the city. There is, therefore, apparently just sufficient land for the purification of the sewage created by the present population, if it could be wholly applied to grass, and if it could be guaranteed that every acre could be used for the purpose; but as an unobjectionable exit for the sewage must at all events be secured, whether it is taken by farmers or not, it seems imperative that a greater extent of available land should be at the command of the promoters, or that a more distant exit for the sewage should be obtained. The 1500 acres of land on the north side of the Clyde are so situated that they might be irrigated with the sewage of the higher portions of the city by gravitation; but as this land is at present in close proximity to residences, and as the tendency of the city is to move westwards, and to increase in that direction, it will probably not be many years before the ground is taken up for other purposes and sewage irrigation have to be abandoned. With respect to that on the south side, also, there are the towns of Renfrew, Paisley, and Johnstone, containing together a present population of between 40,000 and 50,000 persons, whose necessities must be considered, and who may be said to have a prior claim upon a portion of the land included in the above estimate. For their accommodation, at least 1000 acres must be deducted, which, with the deduction of the 1500 on the north bank of the river, would reduce the available area to 7000 acres—a quantity clearly insufficient for guaranteeing the purification of the sewage. We have, therefore, looked to more distant places with a view to securing an outlet which will be unobjectionable in itself, and which will render the promoters independent of farmers, at the same time that it will give them the means of purifying the sewage for themselves, and obtaining from it a fair return for the money expended, if not a considerable profit.

"These results cannot be obtained within the basin of the estuary of the Clyde; any scheme which permitted the possible discharge of foul sewage into the river would not remedy the evil complained of. We have shown that even for the present quantity of sewage, there is not land enough within the valley of the Clyde to effect its purification. We cannot recommend the adoption of any scheme which proposes to gain land from the estuary for the purpose of sewage irrigation. The rugged character of the coast beyond Erskine House, and the succession of populous places for a long distance down the Firth, together with the absence of any land suitable for the reception of the sewage, prohibit all idea of carrying it away by a conduit in that direction. The northern shore of the firth opposes even greater obstacles to any work of such a nature, and we are therefore compelled to abandon all thoughts of using the Clyde, or the Firth of the Clyde, as an embouchure for the sewage.

"The nearest available district is that which has been frequently suggested by others, first, we believe by Mr. Laurence Hill, viz., the coast of Ayr. Between Ayr and Saltcoats, and especially between Troon and Irvine, there is a tract of sandy land, of several thousand acres in extent, upon which the sewage might be poured, and which might thus be made of great value. This ground would of itself be sufficient to deprive the sewage of all objectionable character before flowing into the sea, even if none of it were taken by farmers, or applied to land between the coast and Glasgow.

"The point of outlet selected is distant from residences and towns, and any objection which might be raised by landowners if the sewage were allowed to flow direct into the sea from which it might be thrown back on the shore, would be obviated by the promoters purchasing or leasing a sufficient tract of the sandy land alluded to, on which to pour the sewage before finally permitting it to reach the sea.

"The distance from Glasgow, however, is great, and the intervening country presents some difficulties to the construction of the work. Every possible route by which the sewage could be conveyed has been carefully examined, and we have also estimated the relative cost of lifting the sewage high enough to allow it to pass over the intervening ridge at Kilbirnie Loch, and of tunnelling beneath the ridge at no greater elevation than would be requisite to give sufficient fall to the conduit and velocity to the sewage.

"The result is, that we have devised a scheme for intercepting the sewage of the higher portion of Glasgow at an elevation of about 60 or 70 feet above Ordnance datum, and, by tunnelling through the intervening ridge, conveying it by gravitation alone to the coast between Irvine and Troon. An intercepting sewer at this level will remove the sewage from one-fourth of the population of the city. For the remainder, we propose to construct two other lines of intercepting sewers; one, the middle level sewer, at an elevation of 20 feet above Ordnance datum, which will take the middle zone, containing nearly one-fourth of the population, and the other or low level sewer, at the level of Ordnance datum, which represents the mean level of the tide, by which the sewage will be diverted from all the lower portions, or remaining half of the city. These sewers are shown on the plans which accompany this report.

"The sewage from the high level district will be concentrated near the junction of St. Ann Street with Duke Street, at Wellpark Free Church, and from thence conducted by a cast-iron siphon pipe along Hunter Street, and a new street, in continuation of Hunter Street, between Gallowgate and Great Hamilton Street, to Glasgow Green, across the Green and over the river a little below St. Andrew's Suspension Bridge, across Gorbals to Cumberland Street, thence along Cumberland Street, in a direction parallel with the river, to a pumping station close by the side of the Paisley Canal, and between the Canal and the Glasgow and Paisley Railway, a short distance to the west of Pollokshields. The sewage conveyed by this siphon will be discharged at a level of about 48 feet above Ordnance datum, and will there be conveyed by a circular conduit, 9 feet in diameter, to the coast of Ayr, about midway between Troon and Irvine. The sewage of the middle level intercepting sewer will be carried in the same line as the high level sewer from Glasgow Green to the pumping station, to which it will flow by gravitation; the Bridge over the Clyde, which will carry both this and the high level siphon, being so constructed that a headway of 12 feet at high water shall be left for navigation. Into the middle level sewer on the south bank of the river all the drainage of the higher parts of Gorbals will flow, and be also carried by gravitation to the pumping station at Pollokshields.

"The sewage received by the low level sewer on the north side will be concentrated near or at the north-westerly end of Glasgow Green, and there lifted by steam-engine and pumps 20 feet into the middle level sewer, by which it will also be conveyed by gravitation to the Pollokshields pumping station.

"The drainage of the lower part of Gorbals will be effected by a sewer, commencing near St. Andrew's Suspension Bridge, at a level about 8 feet above Ordnance datum, which will be continued along the river bank to Windmillcroft Dock, and thence along the Paisley Road to the pumping station, to which the sewage will be carried by gravitation. The sewage of Govan, and the intermediate district between Govan, Mavisbank, and the Paisley Road, will be conveyed by another sewer at about the same level as the sewer just described, which will also discharge its sewage at the pumping station by gravitation.

"Here the whole of the sewage of the middle and low level sewers will be lifted to the level of the lower end of the high level siphon, which is the commencement of the great conduit which will have to convey the joint volume to the sea. The middle level sewage, which is due to about a quarter of the whole city, will require lifting about 30 feet, and the sewage of the low level sewers, which will be due to about half of the whole population, and which will receive also the waters of the factories along the Clyde, will have to be lifted a height of 42 feet. The mean lift of the whole sewage of Glasgow will be by these arrangements reduced to about 32 feet.

"From the pumping station, or rather from the end of the high level siphon, the conduit to the coast of Ayr will run nearly alongside the Paisley Canal to Johnstone. It will be wholly covered, and will avoid the town of Paisley by a shallow tunnel of two miles in length. Immediately beyond Johnstone it will run into tunnel for 17 miles in length, at an average depth of a little under 100 feet, no part, except at one isolated point, being more than 120 feet. The tunnelling will cease a little to the south of Kilwinning, from whence the conduit will be cut across the sand hills to the sea shore and covered over. The conduit throughout its whole length will be in the coal measure formation; and, by the position of the workable coal and minerals, the line selected will fortunately escape all workings, except for the last 2 miles, and be constructed in ground not liable to be affected by mining operations. The tunnel will be wholly in "blaes," or sandstone, and a tunnel at so small a depth from the surface in these strata may be constructed nearly as cheaply as if it were made in the ordinary way of 'cut and cover.'

"For the irrigation of the sandy land on the coast, already alluded to, it would be necessary to raise the sewage, or so much of it as may not have been parted with by the way, between 40 and 50 feet; but the cost of this should not be debited to the general scheme, because its success, in a sanitary point of view, is in no way dependent thereon. It would be a further outlay, incurred with commercial objects only, and would probably be productive of a large return of revenue.

"The special advantages of treating the sewage of the city in the way we have described, assuming that it must be taken to the Ayrshire coast, are the following:—One-fifth of the whole sewage is conveyed away by gravitation without pumping, no portion will require lifting more than 54 feet, and the average lift will be, as stated, 32 feet, omitting in this calculation the lift on the coast for farming purposes. The difficulty and danger of passing beneath the Clyde below the harbour, in the manner suggested by other projectors, is avoided. All danger of deposit taking place in the hollow or lowest part of the high level siphon is avoided, as it is so arranged that it has a continuous fall to within half a mile of the pumping station, and by a branch from the point at which it begins to rise, the siphon will possess the important advantage of being capable of being scoured out by gravitation into the river below Mavisbank, or into the low level sewer on the south side.

"In arranging the intercepting sewers in the city, and in fixing their various dimensions, as well as the dimensions of the main conduit which must carry the whole volume away, we have designed them in accordance with the calculations and conclusions contained in a previous part of this report; viz., on a scale of a quantity of sewage which, at its maximum volume, will flow into the sewers at the rate of 110,000,000 gallons in twenty-four hours. The several intercepting sewers are of course proportioned to their contributions respectively towards this gross quantity; but although 110,000,000 gallons is the maximum quantity of sewage we are proposing to provide for, it will not be necessary to construct sewers which shall carry this quantity. The *average* volume on any day on which this maximum has to be received and disposed of will be little more than one-half, and the storage capacity in the vacant space of the sewers, when less than the full quantity is being carried, is such that sewers in the city capable of conveying, when full, 100,000,000 gallons, and the main conduit equal to 80,000,000 gallons per day, if the flow were continuous, will carry away or impound for the time, the maximum quantity of 110,000,000, which will be the probable volume of sewage forty years hence, and will carry also some rainfall in addition. When the sewers are not receiving the maximum quantity of sewage, a large volume of rainfall can of course be received and dealt with; the result being that, according to the quantity of sewage contained in, or flowing through the sewers at the time of heavy rain, and according to the continuance of the rain, rainfalls at rates varying probably from one-tenth of an inch to 2 inches in twenty-four hours, may be carried away without the necessity of any portion of the contents of the sewers being discharged into the harbour. Nothing but continuous heavy rain can overcharge the sewers. Moderate rain, though long continued, and thunderstorms and heavy rains for short periods, can all be received, partly impounded for a time, and ultimately discharged, without the necessity of using the overflows, which we have nevertheless suggested and recommended as measures of convenience and precaution.

"The provision we have made assumes that all the water used will be doubled, and it includes all the water which may be required for trade, although much may probably be sent direct into the river. We have, therefore, gone to the fullest extents which the future requirements of the city can reasonably warrant.

"The intercepting sewers will vary from 2 feet 6 inches by 1 foot 8 inches to 4 feet 6 inches circular, and the main conduit will be a circular culvert, 9 feet in diameter, and have a fall of 20 inches per mile. The minimum rate of flow in the sewers will give a velocity which will be sufficient to prevent deposit, being never less than $1\frac{3}{4}$ feet per second, or $1\frac{1}{5}$th miles per hour, and, when full or half full, $2\frac{1}{2}$ feet per second or $1\frac{7}{10}$ miles per hour.

"In describing the broad features of the scheme we have suggested, we have omitted many details and calculations, and we have avoided alluding to several points which may perhaps be thought entitled to discussion; but we have been anxious to confine our observations within reasonable limits, and to submit a report which can be easily comprehended and as free as possible from perplexing minutiæ.

"One point, however, we must not omit to refer to. Of the 90,000 families which the population of Glasgow is estimated to consist of, 40,000, it is stated, are without water closets. The night soil from these families is at present removed by the Board of Police, and it, of course, adds considerably to the value of the ashes and street sweepings along with which it is removed and ultimately mixed. The total value of the ashes, street sweepings, and night soil which are thus removed, is estimated at £18,000 per annum, and the total cost of cleansing the city is £27,000 per annum, leaving the net cost of cleansing £9000. If water closets were substituted for the present arrangements, the value of the material taken out of the city would be reduced, and the net cost of cleansing increased, while, on the other hand, the value of the sewage would be proportionately enhanced. It may be, however, that any change in this direction would be gradual and probably unadvisable; at any rate, we do not recommend any alteration in the system now pursued, as we have no doubt future details will accommodate themselves to the exigencies or convenience of the inhabitants, and be carried out eventually more satisfactorily than they could be by any sudden radical change.

"The gross estimate of all the works of interception and conveyance to the sea, with the engine power and pumping stations required for raising the sewage to the requisite elevations, amounts to £1,089,756: of which £374.756 are due to intercepting sewers and siphons down to the pumping station at Pollokshields; £50,000 for engines, pumps, and pumping stations; and £625,000 for the main conduit betwixt Pollokshields and the coast near Troon.

"The power required at the pumping engine stations in order to be master at all times of the sewage, which will now require to be lifted, is 500 horse-power; and we estimate that of this 273 horse-power will be required to work constantly on the average of the year, the annual expense of which will be £3550.

"Including all preliminary, parliamentary, and subsequent expenses, and accumulation of interest during the construction of the works, the probable gross outlay may be estimated at £1,253,256, the interest of which at 4 per cent. is £50,130 per annum, which, added to the cost of pumping and administration, will give a gross annual expense of £55,000, exclusive of rates and taxes, equal to a rate of 5½*d.* on the pound on the present assessment of the city, and to 4½*d.* in the pound on the probable assessable value of the property in the city six years hence, by which time the works would be completed.

"This is on the assumption that the whole sewage is run into the sea unutilized and unproductive; but it may reasonably be expected that a considerable revenue may be produced by the sale of the sewage for irrigation to farmers, or by its application to sand land near the coast, purchased or leased by the promoters for the purpose of securing efficient purification.

"On referring to our observations on the experience of other places, it will be seen that the value of sewage to the farmer, where applied to the production of grass, is found to vary from ½*d.* to 1*d.* per ton on the average of the year, and apparently to much more than this when applied to other crops.

"Taking the results of the application of a portion of the North London Sewage to prepared land at the Lodge Farm of the Metropolis Sewage and Essex Reclamation Company, during ten months or 300 days of last year, as detailed by Mr. Morton, viz., that exactly one ton of grass may be produced from 100 tons of sewage, properly applied, over and above what would be produced by the land unassisted by manure, we may make the following calculations:—

"The present volume of the sewage, exclusive of rainfall contributions, is 35,000,000 gallons per day, or 156,250 tons, equal at 100 tons for 1 ton of grass to the production of 1562 tons of grass daily for 300 days in the year. Grass produced from sewage at Edinburgh and elsewhere sells for prices varying from 15*s.* to 20*s.* per ton; but taking it at 10*s.* only, on the coast of Ayr, or on the road between Glasgow and the coast, the return from 300 days of sewage-irrigation would be £234,300, or 1·2*d.* per ton of sewage applied, or ·98*d.* on the total sewage of the year.

"Considering the probable weaker character of the sewage as compared with Edinburgh and London, and the greater amount of rainfall on the west coast than on the east, it will be well to take but half of this result, and divide that again between the sewage provider and the farmer who applies it. This will be almost exactly ¼*d.* per ton to the promoters, or £58,524 per annum from the *present* volume of sewage if wholly applied to land.

"We do not venture to think that this sum, which would cover all interest and working expenses, will immediately or for some years be realized; but this seems certain, that if a sufficient area of sand land adjoining the coast be secured by the promoters, and the sewage applied for irrigation, a very considerable margin of profit will be left, after paying interest on the money invested in the farm and the cost of raising the sewage to the required level, and all working expenses.

"The application of the sewage in this way will insure its purification to such an extent as will save the promoters from all danger of creating a nuisance, and the profit will go in reduction of the rates to be levied for the expenses of the undertaking.

"During the latter portion of our investigation we have been, unhappily, deprived by serious illness of the co-operation of Dr. Anderson, whose great and well-known ability, and whose intimate acquaintance with the chemical questions involved in the inquiry, would have added much useful information and great value to this report. Hence the report is signed only by two of those originally appointed. We may, however, state that previous to Dr. Anderson's indisposition, he was able to accompany us in our various researches over the country; and from what we know of his views, we have little doubt that he will concur in the conclusions we have arrived at.

"We have the honour to remain,
"Your very obedient servants,
"J. F. BATEMAN,
"J. W. BAZALGETTE."

We may here add that the sewage question is rising to its due consideration here in Glasgow just at present. The Philosophical Society, which numbers amongst its members some of the leading chemists and medical men, with not a few well-known engineers, have taken the subject up, and, we hope, with the result of doing useful work, in eliciting opinions and suggestions worth having from these practical men of various professions, but in this particular matter inseparably connected together; let us hope too that the society will publish as soon as possible all that it elicits which is worthy of being disseminated.—V.D.

ON FALSE COINING.

By Joseph Newton, Royal Mint.

As promised in the last number of this journal, we shall now attempt to throw some light upon a species of crime which probably came into existence almost simultaneously with the introduction of coined money, and which is practised largely at present: it is that of false or counterfeit coining. In the early and comparatively barbarous periods of English history, it was thought necessary to make the coinage of this country almost a sacred institution, and to protect it from violation by sanguinary laws. Under the Anglo-Saxon *régime*, for example, he who attempted to commit fraud by counterfeiting the coins of the realm was, if detected, condemned to lose the hand by which the crime was perpetrated. To this frightful punishment the cruel and dreadful policy of the Anglo-Norman monarchs added loss of sight and emasculation.

Fortunately the progress of civilization has caused the gradual mitigation of these shocking penalties, although it has not annihilated the crime for which they were inflicted. Down to a recent date false coining was treated as high treason, and death punishments were inflicted upon those found guilty of practising it. As stated recently in an article which appeared in these pages, On Ancient Modes of Coining, the last execution for counterfeiting the money of the realm took place in 1827.

Without entering minutely into the numerous alterations and modifications which at various intervals in the annals of Great Britain have been made and effected in the laws for the preservation of the coinage, we may briefly cite the main points of some of those changes. Sir William Blackstone, in his well-known "Commentaries," thus enumerates or summarizes these. It will be seen that the defacement and depreciation, as well as the imitation of legal money, were dealt with severely. He states that by statute 6 & 7 William III. c. 17, if any person buys or sells, or knowingly has in his custody, any clippings or filings of the king's coin, he shall forfeit the same and also £500; one moiety to the king and the other to the informer, and be branded on the cheek with the letter R (signifying not Rex, but rogue). By a later statute of the same monarch it was ordained that if any person shall blanch or whiten copper, or buy or sell any malleable composition which shall be heavier than silver, and look, touch, and wear like gold, but be beneath the standard; or if any person shall receive or pay any counterfeit or diminished milled (*i.e.*, remilled) money of this kingdom, at a less rate than it shall import to be of (which demonstrates a consciousness of its baseness, and therefore a fraudulent design), all such persons shall be held guilty of felony.

These precautions not being found sufficient to prevent the uttering of false or diminished money, it was enacted by statute 15 & 16 George II. c. 28, that if any person shall utter or tender in payment any counterfeit coin, knowing it to be so, he shall for the first offence be imprisoned six months, and find sureties for his good behaviour for six months more; for the second offence he shall be imprisoned for two years, and find sureties for six months more; for the third offence he shall be held guilty of felony, without benefit of clergy. Also if a person knowingly tenders in payment any counterfeit money, and at the time has more in his custody; or shall within ten days after knowingly tender other false money, he shall be deemed a common utterer of counterfeit money, and shall for the first offence be imprisoned one year, and find sureties for his good behaviour for two years longer; and for the second be guilty of felony, without benefit of clergy.

These and other statutes of a like nature have, however, proved to be at all times inadequate to the protection of the coinage. The censures of the church have been alike disregarded. As early as the year 1123 counterfeiters of the state money, and also the circulators of base coin, were declared by the Council of Lateran to be accursed, oppressors of the poor, disturbers of the state, and excommunicated. Still these crimes prevailed. About 1560–61 false coining appears to have reached its maximum point in this country. At that time a great recoinage took place, and it is on record that of 631,950 pounds of money then called in and recoined, only 214,416 pounds of "fine monies" could be produced, whilst the dross of this mass of metal was so great in bulk as to have been carried to foul highways and byeways where rubbish might be shot. In fact the bulk of waste in this recoinage was enormous, for the difference of weight of the metal as originally sent to the mint and when reduced to standard was 387,534 pounds.

A strange tale is told, too, of the workmen engaged in melting down the good and the counterfeit coins. Most of them fell sick to death through inhaling the noxious fumes of the metal. As illustrative of the skill of the medical men of the period, it may be mentioned that the prescription for the cure of the poor fellows was to the effect, that they should drink water from dead men's skulls. In accordance with this delightful suggestion, a warrant was actually procured from the council, composed of persons as enlightened as the doctors, to take off the heads of traitors and criminals which had been placed on London Bridge and make drinking cups of them. It is reported that some of the invalids found relief from the operation, "although most of them died." It is probable that the sickness arose from arsenious acid given off by the spurious metals; but there can be no doubt as to the wisdom of the remedy applied for its cure.

To this hour the nefarious practice of illegitimate money-making has gone on without intermission. It is known, indeed, that many hundreds of persons in England obtain a livelihood by it, and tradesmen and others are their constant victims. The annual cost of prosecutions for this class of offence is not less at present than £10,000, and yet many of its perpetrators escape. The percentage of acquittals in proportion to convictions is very large. The meshes of the legal net for catching such offenders seem somehow to be too large, as shoals of false coiners annually slip through them to prey again upon honest members of the community.

One curious fact may be mentioned in regard to coinage offences, and that is the fluctuation in their number in different years and at different seasons of the year. It is well known to the officers of the solicitor's department of the royal mint that during a general depression of trade, and when destitution prevails extensively in consequence, they have the greatest amount of duty to perform. The business of the office in question resembles in fact a kind of social barometer. If destitution be rife among what are known as the lower classes of the population, prosecutions for false coining are numerous, and *vice versa.* Before the repeal of the hateful corn laws the cases of criminal trials for the crime in question fluctuated with the price of the quartern loaf. When bread was "down," the solicitors to the mint had comparatively nothing to do. When it was "up," they were overwhelmed with work.

The year 1843 was a remarkable one in respect of prosecutions for coining and uttering base money. The number of persons then convicted of one or other of these offences throughout the country amounted to 400. In that year the poor suffered many privations, and destitution existed to a dreadful extent.

The winter season again is peculiarly favourable to the development of the crimes of false coining and uttering. They are always more numerous as the weather becomes more inclement. The examinations of persons so charged before police magistrates are always excessive in number when the thermometer is down to or below the freezing point. It is supposed, and with very good reason, the facilities for gaining an honest living are greater in the summer time than in the winter, and that during the latter period the crime is resorted to more from (what is considered) necessity than from choice. In the dark days of winter too there are no doubt better opportunities for passing bad money than in the bright sunshine of mid-summer.

These facts are remarkable, and they are introduced here for the purpose of suggesting to the philanthropist and to a humane legislature the direction in which to work for its removal. Sanguinary and deterrent laws have not checked false coining. It remains to be seen whether a milder administration of justice, and a more enlightened consideration of the causes for crime, may not have the desired effect of suggesting truer remedies. If the statistic data just furnished, and which is but an abstract of what might be produced, indicates the origin of one of the evils of our social system, and should lead those in authority to a further consideration of them, the writer will have gained one point which he had in view. We may thus draw in this, as we might do in many another analogous case, the sad conclusion that it is not any inherent love of crime, but want, that is its origin—want, itself the consequence almost always of ignorance: for knowledge is power, and power bread. What then is the lesson? here again it is, Education.

Although, for the most part, false coining is practised on a small scale and on individual responsibility, yet it is not very many years since what might be called a coining company existed in Birmingham, and it comprised men of intelligence and ingenuity. They pursued the art of money-making on a very systematic and extensive scale, and the article they produced, having been struck from well engraved dies, bore a remarkable similitude to that issued from the government establishment. By dint of great vigilance on the part of the law officers of the mint, and some treachery on the part of certain members of the "company," the gigantic concern for cheating her Majesty's lieges was broken up, and its promoters were subsequently transported. It is not probable that any such organization exists at present in this country. False coining is a retail trade, but many persons are undoubtedly engaged in it. Vast numbers of florins of a spurious character are annually put into circulation, and the worn condition of a large proportion of our legitimate coinage, of shillings and sixpences especially, offers a temptation which is not lost sight of. Crowns and half-crowns too are frequently imitated, for almost all of these are being rapidly reduced to the uniformity of plain surfaces.

(*To be continued*)

ENGINEERING EDUCATION.

We deem it desirable to present to our readers the following extracts from the inaugural address of Professor Fleeming Jenkin, lately delivered when taking his chair for the first time as Professor of Engineering at the University of Edinburgh. The account given of engineering education in France, although we are not prepared to subscribe to its views throughout, will be read with interest by many.

> "What to do is the question. In most departments of knowledge precedents lie to the hand of the professor. Doubtless the teaching of any man of real talent will always contain much that is due to the man himself; but in classics, mathematics, and many branches of applied science, the methods of teaching are reduced in great measure to a system, and for these studies the student can find text-books of acknowledged excellence; not only has the country he will traverse been surveyed, but roads more or less passable lie before him, leading to well-known ends. The subjects of examination and the standards of excellence are also tolerably defined; but the engineering student has hitherto enjoyed none of these advantages, and a Professor of Engineering in this country finds that he has still to create that system of instruction which in other Faculties needs only to be developed and improved.
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> "One brilliant exception proves the truth of this assertion by the very clearness with which it shines in the general gloom. I refer to the sister University of Glasgow, where Professor Rankine has taught a class, continually increasing in numbers and importance—has written a series of text-books combining originality and sound practice more admirably than any I am acquainted with in any language, while by his genius for research and bold speculation, he has rendered his Chair of Engineering famous throughout the world, and has done as much to relieve our profession from the general charge of ignorance in the higher branches of theory as was possible to any one man.
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> "But one man, however great his powers, is not enough, and even if it were possible for me to follow in the brilliant path indicated by Professor Rankine, it is not desirable that all the teaching should be of one type. When, therefore, I received

my appointment to this chair, I determined, personally, to examine the methods employed on the Continent for the instruction of engineers who receive a systematic education in public colleges of great magnitude. How far it is possible or desirable to imitate the work done in these institutions is a question of importance to us all, and of the greatest possible moment to myself.

"The position of an engineer abroad, in general, differs much from that of his English colleague or competitor, and in France the difference is greater than in any other country.

"The distinction existing here between civil and mechanical engineers is far more strongly marked in France And the business of the civil engineer, who is occupied with roads, railways, canals, rivers, harbours, mines, is almost exclusively in the hands of the members of the body called the Engineers of the *Ponts et Chaussées*, forming an important branch of the public service. These government officials correspond to our civil engineers; they are allowed, and even encouraged, to enter the service of private companies and large establishments, but remain all their lives members of their corps: and supported as they are by government patronage, by tradition, by their *esprit de corps* and mutual assistance, and lastly, by their acknowledged distinction and honourable conduct, they enjoy so great an advantage over any independent man who may try to compete with them, that the civil engineer proper only exists as an exception in France. Once a member of the corps, a man is honourably provided for in life: he enjoys rank, certain promotion, a fair income, and, if he have original talent, a certainty of opportunities of largely increasing that income. Nothing, you will see, can possibly be more different from the career of an English engineer, to whom the government is usually nothing, unless it be looked upon as a foe from whom recognition and remuneration is to be won by sheer hard fighting.

"Being public servants, French engineers are educated by government, and in great part at government expense; the career, being so advantageous, is desired by the *élite* of the French youth, and hence, in the competition which determines the admission of students to the Polytechnic School, as the school of engineers is termed, we see 900 picked pupils of eighteen or nineteen, each straining every nerve to win one of 150 appointments annually made. I believe that there exists no competition in Europe comparable with this. The great severity of the examination is so well known, the fact that five out of six must fail is so obvious, that none but young men who have already gained distinction in the great public schools dream of competing. I remember when myself at school in France, the mere fact that a lad had determined to enter the arena, rendered him an object of awe and admiration to all of us years before the final trial came. In this trial they are examined in plane and solid geometry, in analytical geometry of two and three dimensions, descriptive geometry up to curved surfaces; algebra, including the general theory of equations, series, functions simple and derived, &c.; physics, chemistry, an old language or two, and shaded mechanical drawing. An English engineer reading the list of subjects is tempted to exclaim "What more can they want before beginning the practical part of their profession?" But the select 150 are a long way yet from that. For two years longer they are employed in purely theoretical studies, that is to say, the higher mathematics, theoretical mechanics, mathematical physics, curious problems in descriptive geometry, with a little drawing and language as recreations. During these two years each of the 150 is engaged in a daily struggle for about five-and-twenty highly-coveted posts. The three who are at the head of the class-list at the end of the two years gain the proud title of Engineers of Mines, the rest are humbler members of the *Ponts et Chaussées*, while the 125 who fail have to content themselves with looking after the state factories for powder, tobacco, or saltpetre, or, worse still in their estimation, they sink into mere royal engineers or artillerymen. They may even fall as low as the navy or marine-artillery, for, strange as it may seem with our misconceptions of the French character, the civil appointments rank infinitely higher in the estimation of the competitors than the military posts.

"Thus we see that nearly 900 picked pupils compete fiercely, in the hope of ultimately becoming one of the five-and-twenty who may bear during their lives the coveted title of Engineer. And the five-and-twenty thus annually selected are practically the only recruits received by the whole body of French civil engineers. As we have not five-and-twenty prizes of an analogous nature to offer, I very much fear that considerably fewer than 900 students will besiege my class-doors here, and yet I am not wholly without hope that in time five-and-twenty men may leave this College yearly who shall not be much less valuable to their country as engineers than the five-and-twenty prizemen of the great French school

"Let us accompany them a little further on their career. They have not yet got to practical work. For three years they attend another school, the school of the *Ponts et Chaussées*, or the school for engineers distinctively. Here they are taught in classes how to apply their theoretical knowledge to practical problems, and for six months in each year they are sent into the country to see some practical work; there are no more competitions, and the life is now an easy one; at the age of about four or five and twenty they leave college and are sent into the provinces to begin real work, which for them is chiefly a matter of routine, concerning the administration of the law as to the maintenance of all public works under government control or inspection,—*i.e.*, in France, roads, canals, rivers, harbours, railways, and telegraphs. Too often the young man who has received a mathematical training equal to any that Cambridge can give, sinks into apathy under this occupation, and plods his life through in a lazy comfort, without ambition, but with no fear as to the future, without failure, but without success. This will hardly be the fate of a young man leaving a Scottish university, and therefore my hope is not presumptuous, that, fairly equipped with a knowledge of the principles which in practice engineers are called upon to apply, spurred on by the necessity of making their daily bread, by a noble ambition for distinction, and by the energy of the national character, our students may go out into the world with the hope and the determination that they to their country will not be of less value than the highly trained athletes of France.

"In the education given to mechanical engineers in France, we find much that is worthy of our admiration. Their mechanicians form no guild, protected against competition; they have to work and strive, subject to the same hard laws which determine commercial success abroad as at home, and they are rivals whom we must respect, if we do not fear them. Their marked success of late years has chiefly led to a demand for a better technical education in England, it being well known that much of their success was due to the excellent education which they received, chiefly in the Ecole Centrale of Paris—where the instruction given is very similar to that offered by the great polytechnic schools of Germany and Switzerland. These great colleges at Zurich, Carlsruhe, Stuttgardt, and several other German towns, offer, with the Ecole Centrale of Paris, an education to engineers which is altogether admirable, so far as that education can be given in colleges. They are all protected by an entrance examination, only a few degrees less severe than that required to win an appointment to the French polytechnic school; they have no posts or appointments to offer as prizes, and yet crowds of students annually strive hard to gain the mere privilege of admission.

"How are we to explain this fact? The education at Zurich no doubt is cheap, but the fees for the Ecole Centrale, which is a day school, amount to £32 per annum. The subjects for the entrance examination, intended for young men of seventeen or eighteen, comprise a complete theoretical as well as a practical knowledge of arithmetic; algebra, including quadratic equations; the binomial theorem, and the properties of logarithms and series, with the theory and use of the slide-rule, geometry plane and solid, descriptive geometry, involving the determination by geometrical methods of the exact forms of the intersection of various surfaces of revolution, as well as the ordinary conic sections, the elements of trigonometry, analytical geometry of three dimensions, the elements of physics, chemistry, and natural history, with drawing, described as geometrical, architectural, mechanical, and free-hand. Yet last year 500 pupils competed for admission, and only 220 were accepted, having absolutely no privilege whatever, except that of working very hard for three years, and paying £32 per annum in school-fees. An equivalent examination guards the German colleges, and yet Carlsruhe counts 451 students, of whom 148 will become engineers, and Zürich 681 technical students, of whom 206 are educated as civil and mechanical engineers. Some will tell you that this rush of young men to the large technical schools abroad is due to the appreciation by their parents of the great advantage of scientific training. In truth I believe this has very little to do with it. Parents, abroad as in England, are anxious that their sons should readily make a living, and therefore desire that their sons should follow the well-known and beaten paths which lead to recognized professions.

"Now, abroad, this path to the work of an engineer lies through these great colleges. The English system of apprenticeship does not exist, consequently the one letter of recommendation which proves that a young man is worth a salary in an engineer's office, or in a mechanical workshop, is a diploma from a polytechnic school. Therefore the schools are full. In England, the path to employment as an engineer lies through the office or workshop of a civil or mechanical engineer, and therefore we find that young Englishmen and their parents crowd the doors of the offices and workshops, offering premiums of £300 or £500 for the mere permission to pass three years unheeded inside the magic gates, which must be passed to gain an entrance into the profession. True, abroad there is no law which requires a diploma from a man before he can practise. True, in Great Britain men may and do rise from the ranks, and become the most eminent of all our engineers, but it is not the less true that a young foreigner of education finds the only recognized entrance to his profession through the colleges, and that a young man here must look to pupilage or apprenticeship as the only recognized beginning to his career as an engineer

"The two systems cannot well be combined. The foreign plan requires a young man to study in a college till the age of about twenty-three, when it is too late for him to think of entering an office or workshop for three more years, paying a heavy premium and receiving no salary.

"Before considering which is the best system, it will be well to give you a somewhat fuller account of what is done in these great technical schools. At Zurich and at Carlsruhe a staff of from forty to fifty competent professors gives a technical education to the students. Not only do they teach mathematics, mechanics, physics, geology, chemistry, but they teach how the knowledge of all these elements is to be applied to practical problems in every department of engineering. The pupil begins by designing screws, bolts, rivets, or walls and culverts, and ends by designing, under the master's eye, the most complex machines and the most elaborate bridges and harbours; he is shown the practice of all nations; he is forced to calculate his work so as to meet the requirements of real problems, and so thoroughly is this done, that students do leave these colleges well able to earn a good salary in the drawing office of the civil and mechanical engineer. I could not have believed this to have been possible had I not seen it; and my personal inspection of the colleges taught me to marvel at the combination of theoretical with practical knowledge evinced by the German professors. At the Ecole Centrale I found that the system was similar; in addition to the usual courses of lectures, projects were each month submitted to each class; that is to say, they received a short specification of a certain work to be designed. The designs, specifications, and estimates were to be ready in one month's time. Meanwhile each pupil was free to consult books, friends, even the professor himself, but he was bound to produce an original design, making the drawings in the class-room. When each design had been sent in, the professor cross-examined every pupil as to his motives for choosing the dimensions, materials, and forms adopted, and finally, he corrected and criticized the design. Couple with this, admirable lessons in the higher mathematics, pure and applied, and you will not wonder that the Ecole Centrale turns out men who are thorough masters of the theory and practice of design applied to engineering works.

"This is the foreign system. What is ours?

"Young men, at the age of about eighteen, enter the office of a civil engineer. Usually few questions are asked as to previous training. Etiquette requires the engineer to show a certain reluctance to receive the pupil, and, in fact, the ordinary pupil is a sort of nuisance in an office, only tolerated in consideration of the fee which accompanies him. From personal experience, I can declare that most pupils are so ignorant of algebra, that they are not only incapable of working out a result for themselves, but actually cannot apply the simple formulæ which are given in engineers' pocket books. The calculation of the solid contents of a wall is often beyond their powers. Their arithmetic is very shaky, and a knowledge of physics, chemistry, geology, or the higher mathematics is wonderfully rare. The men have too often chosen the profession from an idea that it is pleasant, and because, forsooth, it is guarded by no preliminary examination. Not even a pass-examination is required, and the ignorance of some pupils, especially in mechanical workshops, must be experienced before it can be believed. They really seem to think that a little turn for making toy-models shows a bent for mechanical engineering such as will justify them in expecting success."

(*To be continued.*)

NOTES FROM FOREIGN JOURNALS ON RECENT METHODS AND IMPROVEMENTS IN STEEL AND IRON-MAKING.

No. I.

BESSEMER STEEL.

THE vast excitement which characterizes the present period as to new and improved methods of iron and steel making, nearly all over the moving world, and the impending revolutions in structural materials and in structures and machinery of all sorts which these improvements herald, are more than sufficient justification for our presenting to our readers some notes as to what is doing, and how thought on these subjects is moving, abroad as well as at home. As respects the latter, we have recently given a pretty full account of that which is at once the most recent, and, if we may judge from the animation of the controversy on the part of rivals which it has elicited, perhaps one of the most important advances made by us at home in Great Britain in steel-making, viz., by the Heaton process, as to which, next month, we shall be in a position to lay still farther facts before the readers of the *Practical Mechanic's Journal*. At present we propose to deal with foreign matters chiefly, and from sources which, issuing only in German dress, are not commonly accessible in England by those engaged in manufactures and trade.

In the *Oesterreich Zeitschrift* Prof. Kupelwieser has made the following interesting communication on the chemical view of the Bessemer process. The imperial *Oberverwesamt Neuberg*, along with the products of Bessemer metal, sent to the exhibition at Paris, has given analyses of the pig iron employed, of the intermediate products, of the finished steel, and of the drosses or slags which separate with the intermediate and final products; the real qualities of the products are thus shown not only to the eye by the exhibited samples, but also to the intellect by the analyses given. The imperial *Oberverwesamt Neuberg* has communicated the results of these analyses, which have been made at the "Imperial General Landes-Münzprobiramte" (government assay-office for coinage of the mint) of Vienna, to the authorities of the "Berg-akademie" (school of mines) at Leoben. As any analyses which thoroughly investigate the whole Bessemer process have been published in but very insignificant numbers, Kupelwieser thinks a closer consideration important; and although it may appear premature to base a complete theory of the process upon a series of investigations made from results of a single charge, the results of these investigations may, nevertheless, be accepted as a desirable contribution towards the understanding of the process. Further investigations, carried out not only in a similar or even more perfect manner, however, will alone furnish a thorough knowledge of the chemical part of the Bessemer process, which has been treated as regards its theory up to the present time in a very insufficient manner. The very interesting article of Director Grill ("Jahresbericht," 1859) is to this day the only one which attempts to explain the chemical conditions of the Bessemer process minutely, and that has been simply repeated, in different places and by many authors, with several little additions and alterations. It appears that Grill has been in the possession of analyses of the final products, and it is to be regretted that he did not publish them; a complete series of analyses must be, therefore, yet the more desirable. The charge referred to by Kupelwieser's researches consisted of dark grey pig iron, produced in furnace No. 2, from Altenberg ores, with an addition of about 16 per cent. of lime, and the consumption, as may be stated in passing, of 19 cubic feet of soft charcoal; it was used direct from the furnace. The charge was 62 centners, 80 lbs. of Vienna weight, and in the following Table I. and II. the pig iron and drosses of the furnace are indicated by A. The pig iron was poured into the larger converter, and the first charge was worked with 49 twyer holes of 4 lines diameter, and on an average a blast pressure of 20 lbs. per square inch; the operation lasted 28 minutes. After finishing the first part of the operation (*periode*) a sample was taken, and the products are indicated as B in Tables. In this case the small quantity of drosses which the converter contained was remarkable. The carrying through of the second period or operation required only 7 minutes, with an average blast pressure of 18 or 19 lbs. per square inch, and it passed without any ejection of iron; the products are marked C. The third period lasted only 3 minutes, with a pressure of nearly 19 lbs.; the products being marked D. Now, after the converter had been tilted over, three centners of pig iron were added, and after the evolution of gases had ceased the finished Bessemer metal was poured out. The final product consisted of 54 centners, 60 lbs., of iron (*eisen*), and a quantity of drosses, the weight of which we regret was not ascertained; this product is E. The charge could not be considered as a very hot one, and the waste was found to be large, nearly 17 per cent.; this amount was perhaps partly due to taking samples. The analyses made of the samples thus taken at successive periods gave the following results:—

TABLE I., A.—IRON PRODUCTS.

	A.	B.	C.	D.	E.
Graphite, ...	3·180	—	—	—	—
Combined carbon, . . .	0·750	2·465	0 909	0·087	0 234
Si, ...	1·960	0·443	0 112	0·028	0·033
P, ...	0·040	0·040	0·045	0·045	0·044
S, ...	0·018	traces.	traces.	traces.	traces.
Mn, ...	3·460	1·645	0·429	0·113	0·139
Cu, ...	0·085	0·091	0·095	0·120	0·105
Fe, ...	90·507	95·316	98·370	99·607	99·445
Total, ...	100·000	100·000	100·000	100·000	100·000

TABLE II., B.—THE DROSSES (EDUCTS) OR SLAGS.

	A.	B.	C.	D.	E.
SiO_3, ...	40·95	46·78	51·75	46·75	47·25
Al_2O_3.	8·70	4 65	2·98	2·80	3·45
Fe O, ...	0·60	6·78	5·50	16·86	15·43
Mn O, ...	2 18	37·00	37·90	32·23	31·89
Ca O, ...	30·36	2·98	1·76	1·19	1·23
Mg O, ...	16·32	1·53	0·45	0 52	0·61
K O, ...	0·18		clear	traces.	
Na O, ...	0·14	—	—	—	—
S, ...	0·34	0·04	—	—	—
P, ...	0·01	0·03	0·02	0 01	0·01
Total, ...	99·77	99·79	100·36	100·36	99·87

We may deduce from the facts and from these analyses, something like the following conclusions:—

The pig iron employed was a deep grey aluminous pig iron, with a sufficient amount of Si for its direct use from the blast furnace, and even still sufficient, if remelted with the necessary care. The very small content of phosphorus and sulphur, as well as the great amount of manganese, characterize the pig iron as one of very good quality, and one suited most admirably for the Bessemer process. The copper existing in it is not of any importance. The amount of iron in the whole of the analyses was not determined in a direct manner, but by difference.

It would be very interesting to ascertain whether at all, and if so, how much, the iron in the intermediate products has taken up of ferric oxides. The entire of the graphite has disappeared after the first period, partly blowing out as sparkles in combustion, partly by interior combustion in the metallic mass, or through the transformation of the graphite into chemically combined carbon, which thus has considerably increased. Nearly four-fifths of the content of silicate have been separated; the great content of manganese carried off the sulphur, with the exception of the traces which remained; the content of phosphorus remained unaltered, the percentage, however, increasing as the relative amount of iron was diminished; whilst the content of copper, which had, perhaps, remained unaltered with reference to absolute weight, had also increased a little in percentage. The content of manganese had also decreased considerably, and the product was a pure, white, crude iron, not very rich in carbon.

The separation of the chemically combined carbon takes place, also, in the second period very quickly, as will be seen from column C, for there is observed only a small part of the silicon. We obtain thus, after the termination of the first period, which only lasted 7 minutes, a product which, according to its percentage of carbon, may be looked upon, according to general or commercial classification, as a steel, No. 3 (*i.e.*, according to classification in Germany into 8 classes). The separation of the silicon and manganese takes place in the same rapid manner, whilst the contents of phosphorus and copper remain untouched and unaltered.

After the termination of the third period, we obtain a product which is transformed, by the addition of three centners of pig iron, into a Bessemer metal, of hardness No. 6. Not only the carbon, but also the contents of silicon and manganese, are here increased a little by the addition of this pig iron; it is, however, remarkable that the percentage of the copper should have decreased so considerably by the addition of only three centners of pig iron; and this circumstance seems to indicate that the amount of copper in D is probably given rather too high. The pig iron here referred to is in quality analogous to the spiegeleisen added in England. If we examine the drosses or slags, B, C, D, E, which were separated during the process, with minuteness, they appear to contain a great deal of silicon, as they are either bisilicates, or mixtures of bisilicates and trisilicates of various bases. The fact that the slags, B and C, are so rich in manganese is less remarkable, for manganese oxidates in every refining process quicker than iron; but that they are poor in ferric oxide before the commencement as well as after the termination of the second period—that of the so-called boiling—must be viewed as remarkable, and it would seem that the ferric oxide diminishes as the contents of carbon in the iron does. As the quantity of the slags increase during the course of the process, the quantity of manganese still to be separated continues to decrease; the percentage of manganese in the slags, D and E, becomes therefore smaller, whilst the content of ferric oxide increases, on account of the great quantity of the iron oxidized late in the process. The alumina, lime, and magnesia, as well as a part of the silica found in the slags, come chiefly from the lining walls of the Bessemer converting vessel; the very small content of sulphur and phosphorus may come from the pig iron, but they are very insignificant.

If we calculate from the figures of these analyses, and the known weights of the pig iron employed, and of the products obtained by means of compositions of these respectively, we may determine by the differences the weights of the respective elements separated during the process, as well as the quantity of oxygen required for the oxidation; whence also the quantity of air consumed and the corresponding gases evolved may be obtained. This calculation is based upon the following suppositions—that the carbon is burnt to carbonic oxide (of course, a part of the carbon is blown out at the commencement of the operation as graphite, but it is difficult to ascertain its exact quantity, and, therefore, it has been neglected); Si burns to $Si\,O_3$; P to PO_5; and S to SO_2 or SO_3. Here, of course, there is also an assumption not quite correct, as a part, very small, of the sulphur and phosphorus is found in the slags, though the errors, however, which are thus introduced are so insignificant that we may let them pass. Further, the manganese changes into manganous oxide, under which form it is found in the slags. Iron changes almost entirely into diferric oxide, of which a proportionately small quantity is found in the slags as ferrous oxide, whilst the largest part is blown out under the form of a red-brown smoke. Upon the above facts and data, then, the following table is produced:—

TABLE III.

	Quantity, in lbs., of the charged-in pig iron.	The Bessemer metal obtained consists of lbs.	Thus there have been separated lbs.	Quantity of oxygen required for oxidation in lbs.	Whence have been obtained finally
C, . .	258·59	12·79	245·80	327·73	573·53 lbs. Co
Si, . .	128·97	1·80	127·17	139·07	266·24 " $Si\,O_3$
P, . .	2·63	2·40	0·23	0·29	0·52 " $P\,O_5$
S. . .	1·13	—	1·13	1·69	2·82 " $S\,O_3$
Mn, . .	227·67	7·59	220·08	63·56	283·64 " Mn O
Cu, . .	5·59	5·59	—	—	—
Fe, . .	5955·42	5429 83	525·59	200·22	725·81 " $Fe_3\,O_4$
Total, .	6580·00	5460·00	1120·00	732·56	

The amount of oxygen in 732·56 lbs. = 9066 cubic feet, required for the oxidation, gives with 34,264 cubic feet of nitrogen, 43,330 cubic feet of atmospheric air. This quantity corresponds to an average consumption of blast of 1140 cubic feet per minute of operation on the charge, or to 660 cubic feet per centner of the quantity of the pig iron in the charge; this amount is a little larger than usually supposed, but may find an explanation in the large deficit already referred to.

It would be interesting to compare this amount of blast with that actually supplied by the blowing cylinders, but that is only possible when the absolute volume of blast is known which is supplied by the cylinders, and not merely the amount deduced from the number of strokes and size of cylinder, during each separate period, or in each minute. It is impossible to determine this more than approximately by means of a wind-diagram and the area of discharge alone, on account of the frequent pauses requisite in the blast, especially during the first part of the process. The number of strokes of the blowing cylinder exceeds (at a constant pressure of the blast) 60 per minute, but it is also sometimes reduced down to 20, and so for uncertain times. The volume of gas which escapes *probably* consists chiefly of CO and N, so that 8110 cubic feet CO + 34,264 N = 42,374 cubic feet, or per minute of the period of charge 1115 cubic feet of gases evolved; the increase in their volume produced by the enormous exaltation of temperature has, however, here not been taken into consideration. The correctness of the supposition that the carbon of the pig iron burns to carbonic oxide and not to carbonic acid, or to a mixture of both, requires also to be established. This, however, can only be done by means of analyses of the gases taken directly from the interior of the Bessemer converter, and it will be found difficult so to obtain average sample volumes of these gases. It would also be very interesting to show in what state of oxidation the iron is, which is found in the escaping smoke or metallic fume. Finally, it would be instructive to ascertain the respective weights of the several intermediate products at the moment of taking the samples, either by means of direct weighing or by calculation. We should thus be able to determine the weights of the different elements which are separated during the different periods, as well as the quantities of the escaping gases, which must be much larger during the second period, in consequence of the quick combustion of the carbon, than in the two preceding ones. If the temperature of the fluid iron has not yet reached a degree sufficiently high before this, the more vehement their are the explosions which take place, and the more iron is thrown out and wasted, for the colder the iron is the less fluid it is. The method, at present generally adopted, of reducing this throwing out (abstractedly from the having made a suitable choice of the kind or "brand" of pig iron) consists in suddenly checking the volume and pressure of the blast, and this results in a less quick combustion of the carbon, and hence to a reduced momentary production of gases; yet the loss which is produced by spurting or throwing out with vehemence may in this manner, at least partly, be diminished if not prevented. All these questions, which have been indicated here in a very brief manner, as well as many others closely connected with them, are only to be answered by a continued repetition of taking samples, and by making correct analyses of them. Kupelwieser thinks that we may hope that the chemical part of the process will soon be investigated more completely, for that the example which Neuberg has given will soon find followers and imitation; and we ourselves may add that it is most desirable it should be so, for very much that relates to the Bessemer process has hitherto been kept in an undesirable state of mystery.—ED.

ROSSIGNOL'S APPARATUS FOR HEATING WINE.

M.M. ARMENGAUDS' *Génie Industriel* gives a description of this apparatus intended for the heating of wines, in order to destroy the cryptogamic germs contained in them, and which are so detrimental to the quality of the wine. This apparatus is composed of a cask, T (as shown in fig. 1), with the bottom removed and replaced by a copper boiler, C, coated with pure tin, and the top of which terminates in an open tube, *c*, which is carried up through the cask. The wine is placed in the cask, and the boiler, C, filled with water, which is heated by a fire traversing a circular flue. The water is never carried to the boiling point, but only to about the required temperature of the wine, as indicated by the thermometer, *t*. The boiler, C, does not require to be emptied or refilled, the same water being always used. It is desirable that the water should extend to about one-half or two-thirds of the height of the tube when it attains its maximum temperature.

The beated wine is drawn off through the cock, *r*, and india-rubber tubing, *f*, into casks, F; and the receptacle, T, is immediately refilled, in order to utilize the heat obtained in the preceding operation. When the heating is to be suspended for a time it is advisable to fill the apparatus with wine; but if the interval is long, say a year, for example, it is better to fill it with water, which should be heated, in order to prevent its subsequent decomposition. The arrangement adopted by M. Rossignol to unite the bottom of the receptacle, T, to the boiler, so as to render the joint tight, is shown in detail in fig. 2. A circular flange, *a*, on the boiler fits between two annular rings, the one, *d*, of india-rubber, and the other, *b*, of iron of suitable strength. The cask rests on the india-rubber ring or washer, *d*, and is provided with a hoop, *e*, partially sunk into the wood of the staves, or otherwise secured thereto, and carrying flanges or projections, through which bolts are passed to connect them with the ring, *b*. It will thus be seen that by screwing up the bolts the india-rubber is compressed between the ends of the staves and the flange, *a*, and tbe joint hermetically closed. The receptacle, T, may also be made, if preferred, of a slightly conical or trough shape, which would have the advantage of increasing the heating surface of the upper side of the boiler. In this case, also, the pressure exerted on the hoop, *e*, by tightening the bolts would have no other effect than that of more firmly uniting the staves whilst hermetically closing the joint. It would be desirable for the ring, *b*, which carries the whole apparatus, to rest on a row of bricks, and for the depth of that portion of the boiler which is exposed to the fire to be increased; the india rubber would then be less liable to be heated, and rendered more durable.

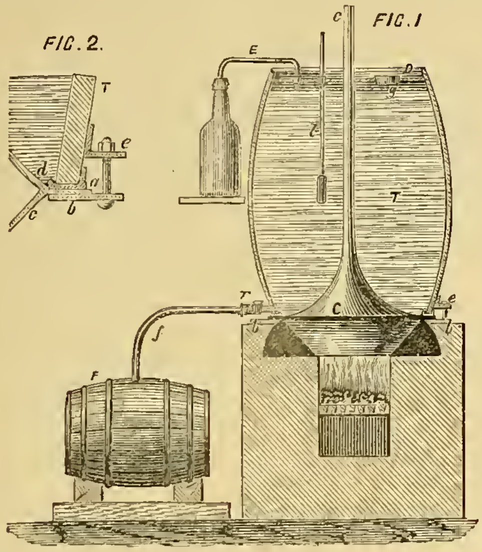
FIG. 2.

FIG. 1

As the volume of tbe wine is increased by elevating the temperature, the receptacle is not entirely filled before heating; the wine is thus put in contact with a certain volume of air, which renders it liable to the injurious influence of quick oxidation. This may be avoided by completely filling it, and providing at the top a glass or tin tube, E, to conduct the excess of wine due to distillation into an adjacent vessel, G. The wine is also subject to the action of a quick oxidation after it has been transferred to the casks; this may be obviated by placing the casks in communication with a vessel containing heated wine, or wine that has been previously heated. The receptacle, T, will answer this purpose by connecting one end of an india-rubber tube at *g*, and the other end to the cask.

CIRCULAR SAW BENCH.

(*Illustrated by Plate* 13.)

MR. JOHN CASSON, of Sheffield, has recently patented some valuable improvements in machinery for sawing wood, some of which are illustrated in our Plate engraving for this month. Although these improvements relate more especially to circular saw benches, some of them may be advantageously applied to ribbon or band saws, and to deal frames. The most important feature in Mr. Cassou's invention is the feed-motion, which is so constructed as to feed the wood continuously up to the saw without the necessity for stopping or reversing the machinery.

Another improvement is the introduction of a vertical adjustment of the top of the bench.

Fig. 1 of the Plate engravings represents a view in isometrical perspective of Mr. Casson's improved saw bench. The saw is carried by spindle turning in bearings fixed to standards, which are cast upon the bedplate, A, of the machine, the upper portion of the saw passing through a slot in the top of the bench, B, as usual. The bench top can be raised or lowered as required (according to the nature of the work to be done) by means of a screw formed on a rib fixed to the under side of the top, which screw passes through a female screw formed in a worm wheel, the under edge of which bears against the upper edge of a socket on the bedplate through which the screw passes. This wheel is turned by means of a worm on a shaft furnished with a hand wheel. Cylindrical legs or plungers are affixed to tbe under side of the top of the bench, which plungers slide in tubular guides, C, bolted to the bedplate, and thereby steady the top at any height to which it is brought. The wood is fed to the saw by means of a single continuously-revolving grooved roller, D, of a slightly conical form (inverted), between which roller and the fence, E, the wood is carried forward to the saw. This roller turns on an axis, carried by a horizontal arm, F—shown more clearly in the details, figs. 2, 3, and 4—which slide telescopically within the horizontal arm or socket, G, so that the arm can be extended when a small saw is used, and contracted when a large one is employed; the longitudinal adjustment of the arm, F, being effected by means of a nut and screw arrangement contained within the screw box, H, which admits, at the same time, of sufficient axial motion of the arm, F, in its socket, G, to set tbe rollers, D, in a slightly oblique position.

This oblique adjustment of the axis of the feed roller is effected by means of a toothed quadrant, I (shown in figs. 2 and 4), fast on the arm, F, into which quadrant gears a worm, K, carried in a bracket, L, cast on the socket arm, G. On turning the worm, 2, the arm, F, will be turned partially in its socket, G, so as to incline sligbtly the spindle or axis of the feed roller (not shown in the details). M is a set screw working in a slot, for the purpose of fixing the position of the arm, F. The socket, G, is formed in a vertical tubular shaft, N, which turns in a bracket bearing, O, fixed to the side of the saw bench, and passes through another tubular sbaft or vertical socket, P, furnisbed with an arm, Q, to the free end, *q*, of which a weighted cord or cbain is attached. The inner tubular shaft, N, is capable of a rising and falling motion within the outer tubular shaft, P, by which arrangement the arm carrying the feed roller can be raised to any height to suit the height of tbe top of the bench, and be fixed at such height by means of a set screw, R, passing through the outer tubular shaft—the arm, F, is caused to press the feed roller forcibly against the wood (which is both guided and carried forward by the roller) by the action of the weighted cord or chain before mentioned, attacbed to the arm, Q. This arm carries a toothed quadrant, S, which receives motion from a worm on a shaft turned as required by means of a hand-wheel, T, tbe worm being so arranged as to be capable of being thrown into and out of gear with the quadrant, by means of a rocking standard connected by the link, U, with the weighted lever, V. In order to introduce the wood between tbe fence and the feed roller tbe worm and quadrant above referred to are thrown into gear, and the hand-wheel, T, is turned until the feed roller is brought to the requisite distance from the fence. The wood is then introduced, and the quadrant and worm being thrown out of gear the weight on the cord or chain comes into action, and tbe feed roller is pressed against the wood. The roller is driven by a chain, W, passing over pulleys, one of which is fixed on the axis of the roller, the other being keyed to the upper end of a vertical central shaft, X, which passes through the inner tubular shaft, N, and also through a worm wheel, Y, to which the central shaft is connected by means of a groove and feather arrangement. The wheel, Y, is driven by a worm on a shaft, Z, which receives motion from tbe shaft, *a*, by means of friction clutches, B, worked by the weighted lever, V. The sbaft, A, derives its motion from the saw spindle by the band pulleys, *c*.

This feed apparatus is capable of separate application to tbe benches of ordinary sawing machinery. When so applied the apparatus is mounted on a separate bedplate fixed underneath the saw bench to which the feed apparatus is to be adapted. *d* is a lever, by means of which the feed roller, D, can be quickly brought out of contact with the wood when required, without throwing the worm out of gear with the quadrant, S. This lever is jointed to the socket, G, so as to hang down out of the way when not in use. The fence, E, is mounted on a saddle, being held thereto by lock nuts, which pass through slots in the fence, and engage in cross slots in the saddle. By this arrangement the fence can be adjusted according to the size of the saw used, and can also be slid off the saddle at right angles therefrom when a clear bench is required. It is moved nearer to, or further from the saw (according to the thickness of the wood to be sawn), by means of a screw spindle, *e*, working in a nut, *f*, and also engaging with a worm wheel, *g*, carried by an axis, *h*, turning in bearings in a sleeve formed on the fence, E. The plain portion of the screw spindle forms an axis on which is mounted a friction roller, *i*, which supports the wood as it is fed to the saw. The ends of the screw spindle, *e*, and axis, *h*, are squared to receive a winch handle. When it is required to adjust the position of the fence with accuracy the screw is turned in its nut, *f*, the worm wheel, *g*, turning with it. When it is required to move the fence a considerable distance towards or from the saw, the axis, *h*, is turned, and the wheel, *g*, gears into the screw, *e*, as into a rack.

The fence having been adjusted to the required position, the hand wheel, T, is turned until the feed roller has been brought back sufficiently far to admit of the introduction of the wood between the roller and the fence. The wood having been introduced, the weighted lever, V, is reversed, so as to throw the shafts, Z and *a*, into gear, by the action of the friction clutch, *b*, and the worm and quadrant, S, are thrown out of gear. The feed roller is thus caused to revolve and press against the wood and feed it to the saw. This roller having a slightly conical form (the smaller end being downwards), presses the wood down upon the top of the saw bench, and prevents the wood from rising or "climbing" from the bench top, and thereby insures a steady continuous feed to the saw, notwithstanding any slight inequalities which there may be in the thickness or form of the wood.

MECHANIC'S LIBRARY.

Adcock's Engineer's Pocket Book. 12mo, 6s., roan.
Drake, Notes on Venetian Ceramics. 8vo, 4s.
Goblet's Theory of Sight. Demy 8vo, 10s.
Head's Royal Engineer. 8vo, 12s., cloth.
Laxton's Builder's Price Book, 1869. 12mo, 4s., cloth.
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Pulleyn's Origins and Inventions. Crown 8vo, 3s. 6d., cloth.
Reed's Treatise on Shipbuilding. 8vo, 30s.
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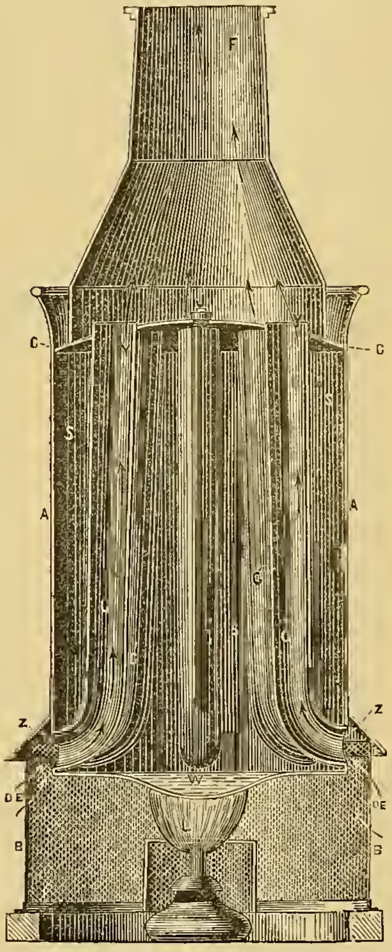
RECENT PATENTS.

HEATING AND VENTILATING.

JOHN JOHNSON, *of Saco*, U.S., A. *Patent dated 16th April*, 1868.

THIS invention has for its object the radiation, diffusion, and distribution of heat, either in the same apartment in which the warming apparatus is situate and heated, or in places remote from where the fire is applied to the said apparatus, and consists in the use of a small proportion of liquid or vaporizable material inclosed within an air-tight cylinder, vessel, or pipe having a large steam space as compared with the volume of the liquid; the radiating and condensing surfaces of the apparatus being so placed that all the water of condensation shall flow back again to the generator, or that particular part where the heat is applied, to be again converted into steam or vapour which fills the entire capacity of the apparatus, and consequently diffuses its heat thereto. It is also proposed to cause steam to circulate through endless pipes or coils having no openings; such pipes or coils containing only a very small quantity of liquid, in proportion to the capacity of the pipe, in a bend or coil of the pipe. One branch of this pipe must be so placed or inclined as to insure the free return of the water of condensation to that part of the coil or generator to which the heat is directly applied. The proportion of liquid to the cubical contents of the radiating and condensing vessel or pipe which has been found to answer well in practice, is about two cubic inches of liquid to one cubic foot of space in the steam chamber or pipe.

This system of heating is applicable to culinary purposes, as well as to warming and ventilating apartments. According to one mode of carrying out this invention, a cylindrical or other shaped closed vessel containing a small quantity of liquid to be vaporized is employed, and a number of air tubes or passages are fitted into it, passing from bottom to top so as to form condensing surfaces for the vapour, and radiators of heat to the currents of air passing up them. The heat may be applied to the liquid either directly under the cylindrical vessel or radiator itself, or it may be applied to a long pipe or tube extending to some other convenient locality, but in communication with the aforesaid radiating vessel. Or in lieu of a radiating vessel a mere coil of pipe may be used; one part of which, namely, that situate at the lowest level, being heated in any convenient manner, so as to vaporize the small quantity of liquid contained at that part. Or a coiled tube or hot-water circulating pipe may be combined with a radiator provided with air-tubes as above described, by having one part of the said hot-water coil passing through the radiating vessel, which vessel contains only a very small quantity of water or other liquid to be vaporized by the heat transmitted thence by the hot-water coil. Or for culinary purposes a jacketted vessel may be used containing in the jacket a small quantity of liquid to be vaporized, the heat being applied directly to the bottom of the jacketted vessel, whilst the food to be prepared is placed in receptacles or wells in the vessel itself, and provided if desired with lids or covers. Or a solid iron vessel or block may be cast round the upper end of two coils or tubes made in a strong iron endless pipe, the lower coil or helix only containing the liquid to be vaporized by the direct application of heat thereto; the heated vapour thus generated rises up the tube and traverses the iron vessel or block, imparting heat thereto. By hollowing this vessel or block and providing it with a lid or cover, it forms a convenient utensil for cooking or preparing food.



In cases where low temperatures are required, ether or alcohol may be used as the vaporizable liquid, whilst high temperatures can be readily obtained by the use of saline solutions, acids or solids, without increase of tension or pressure in the cylindrical vessel or coil.

The engraving is a sectional front view of one form of apparatus for carrying out the said invention.

The cylindrical vessel, A, rests at the bottom upon a suitable stand, B, which supports it above the flame, L, of a lamp or a gas burner: where a fire or furnace is used, the support or base is of brickwork, and is provided with ashpit, grate, and firedoors. A series of air-tight pipes, G, G′, G″, G‴, G⁗, extend from the bottom, D, E, of the cylinder to the top, C, being inclosed between the walls of the cylinder, and having both of their ends open, as at Z, Y, to allow the free upward passage of air in the direction of the arrows. The ends of these open pipes are brazed or soldered steam-tight to the top and the bottom of the cylinder or radiator, A, thus forming an air-tight vessel. It is preferred to construct the tubes, G, with a quarter turn near their lower end, and allow their open mouths to pass through the sides of the cylinder, A, as in this position they are less exposed to heat. A part of the bottom, D, E, is convex, projecting downward, as shown in the drawing. It is obvious that if the vessel, A, contain a large quantity of water, and sufficient heat be applied at L, the apparatus would burst. It will be observed that a very small quantity of water, W, is employed in proportion to the steam space, which water is at the bottom of the vessel, and at the nearest point to the source of heat, and which, after condensation by the contact of the steam with the interior of the cylinder, A, and the exterior of the pipes, G, G, returns to its place at the bottom, D, E, to be again converted into steam. The water is introduced into the vessel at an aperture in the top or cover, C, this opening being soldered up or closed by a screw plug, J, after the air has been partially or wholly exhausted from the vessel. The quantity of water used is varied in proportion to the size of the cylinder; that is to say, the cubical contents of the space within the cylinder must bear a definite relation to the quantity of water that is placed at the bottom of the cylinder, to be heated and converted into steam—say, about two cubic inches of water to each cubic foot of space in the steam chamber.

When the whole of the water is evaporated and the cylinder filled with steam, the application of more heat at the bottom of the vessel merely superheats the steam, without materially increasing the pressure. When the fire is out and the temperature reduced, the steam is all condensed, and the water again takes its place at the base of the cylinder. This operation is also constantly going on when the heat is applied, the water of condensation flowing down the exposed sides of the cylinder, A, and pipes, G; the amount of condensation being greater or less, according to the temperature of the external air.

One advantage attending the use of this system, is that heat is evolved almost immediately, and is ready for use as soon as ebullition takes place in the small quantity of water at W. When the apparatus is exposed to cold and not in use, no injury results from the freezing of the water. Instead of exhausting the air, as before named, the same effect may be produced by boiling the water, W, and soldering or closing the aperture at J, as soon as the steam has expelled the air from the vessel, A. Instead of the air tubes, G, G′, a casing may surround the cylinder, A, and through this space the air may be circulated, and warmed in its passage. The cylinder should be of such form as will offer the greatest resistance to atmospheric pressure, or a "collapse valve" may be used, opening inward, to allow the air to enter when the fire is out, and the steam in the cylinder is condensed.

When low temperatures are required ether or alcohol is used, which vaporize at a low heat, and impart less heat to the radiator or cylinder in which they are contained. Higher temperatures can be readily obtained by the use of saline solutions, oils, or solids, without increase of tension in the cylinder; the boiling point of these bodies being high, the vapour from them will greatly increase the sensible temperature over that of steam of the same tension, when a hermetically closed chamber is filled with these vapours. Water is applicable to nearly all general purposes; but for special uses, other liquids may be applied, keeping in view always the principle before named, of a very large space in the chamber as compared with the vaporizable material or liquids. A conical cap or funnel, F, may be provided, and the heated air that rises through the tubes, G, may be conducted by pipes to distant apartments.

DRESSING MILLSTONES.

James Graham Walker, *of Bonnington Steam Mills, Edinburgh.—Patent dated 6th May*, 1868.

This invention specially relates to an arrangement of mechanism to be employed for dressing millstones, whereby that operation is performed in a much more rapid and effectual manner than by the means for effecting it hitherto employed. The mechanism consists of a horizontal slide upon which a saddle travels, carrying a cross slide, and to this the cutting mechanism is attached. The cross slide carries a lever, the outer end of which is formed into a holder for retaining the tool by which the faces of the millstone are dressed. At the rear end or part of the slide a revolving shaft is placed, which carries a cam, and a small engine is fixed to the apparatus by which the shaft is driven; so that, by the revolution of the cam, a reciprocatory motion in a vertical plane is given to the lever, and as the tool falls, the necessary dressing cut is effected—springs or weights being placed to act on the lever, so as to increase the intensity of the blow. The depth of the cut is regulated by one or more set screws, and the arrangement of slides placed at right angles enables all the lines of dressing to be made parallel and similar.

Fig. 1,

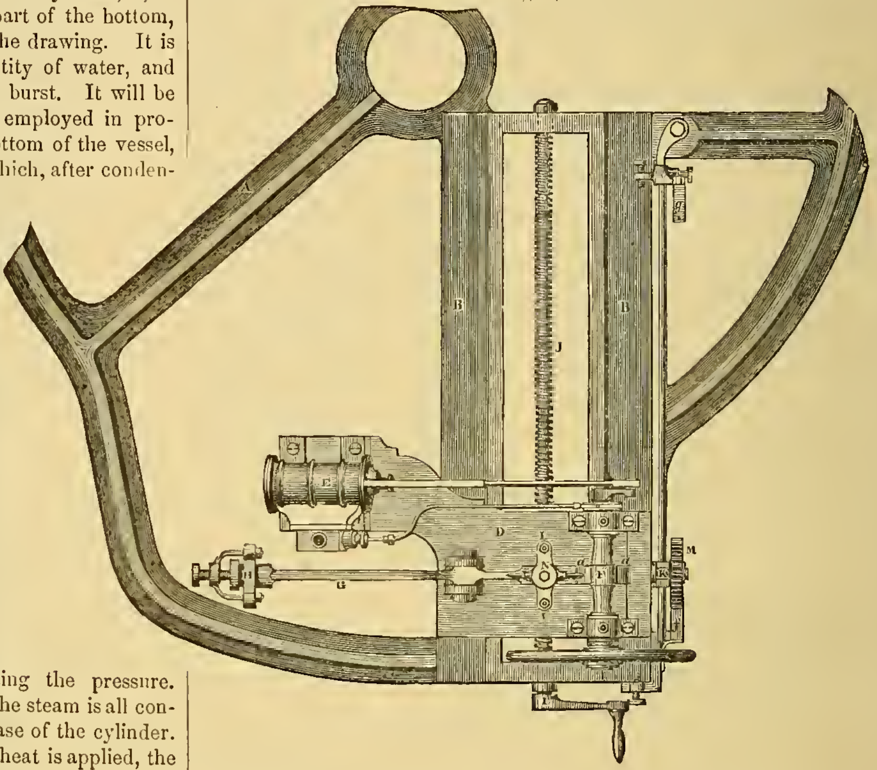
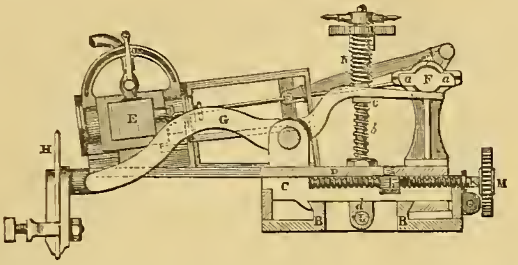


Fig. 1 of the engravings is a plan, and fig. 2 is a transverse section, of a millstone dressing machine, according to this invention. The machine consists of a sole plate, A, on which there is cast or fixed a slide, B, fitted with a compound or double saddle, the under part, C, of which serves as a slide for the upper part, D, which carries a small engine, E, actuated by steam or compressed air, for the purpose of rotating the shaft, F. The saddle, D, also carries a lever, G, one end of which is formed into a holder to receive the dressing tool or pick, H, and the other end is situated under the shaft, F, and actuated by the cams or wypers, *a*, so as to elevate the end of the lever carrying the pick, H, by the fall of which the necessary dressing cut is effected. For the purpose of increasing the intensity of the blow, two spiral springs, *b*, are fitted on the columns, I, under a cross head, *c*, by which they are compressed when the lever, G, is actuated by the cams, *a*, and when relieved from the pressure of the cams, the springs, *b*, expand and force up the end of the lever, thereby causing the pick, H, to fall with greater force. In operating with the machine, the compound saddle carrying the dressing mechanism is traversed to and fro, longitudinally, by a screw, J, working in a nut, *d*, and a transverse motion is given to the upper saddle, D, by a screw, K, working in a nut, *e*. The screw, J, is operated by a handle, L, and the screw, K, by an index wheel, M, which is turned by the catches, *f*, *g*, these being set so as to move the saddle, D, in a transverse direction, a distance equal to the space between the grooves in the millstone, and the depth of these are regulated by a set screw, N. The machine is fastened on the millstone by a spindle or bolt passing through the centre of the sole plate, A.

Fig. 2.



REVIEWS OF NEW BOOKS.

A Treatise on the Steam Engine, &c., &c. By John Bourne. Being the Eighth Edition of "A Treatise on the Steam Engine," by the Artizan Club. 4to, Plates. Longmans & Co. 1868.

Examples of Modern Steam, Air, and Gas Engines of the most Recent Approved Types, &c., &c. 4to, Plates. Parts I. to VII. To be completed in 24 parts. By John Bourne, C.E. Longmans & Co.

The original edition of this work, though a fair proportion of its matter came by help of the scissors from Tredgold and others, was for its time, more than twenty years ago, a useful book; and valuable in so far at least as that in a cheap form it supplied a good deal of information upon its special subject, unattainable then in so collected a form and at so reasonable a cost. Published at first in numbers in connection with the *Artizan*, it dropped just into a lucky chink in time—for Tredgold had passed away, and Farey, whose prim, pretentious, and "auld warld," though able and historically unique work, was never completed, had disappeared also; while upon the Continent the engine-maker was scarcely more than beginning to work, and the foreign literature of the steam-engine not begun, except by Prony (already old), and by De Pambour and Navier, and one or two other treatises. There was thus in 1846–50 a stage so clear, that almost any treatise upon the steam-engine of average fullness and exactness was pretty sure to be welcomed and largely bought. It seems to us that this opportuneness securing its first shove into popular favour, and the several years that elapsed after the date of its first edition before any newer or better treatise came to compete with it in English, have been the main causes of the continuance of reprints, or so-called new editions, of this work, which for the last ten years at least has been far below the standard, theoretical and practical, demanded by its subject.

Tredgold's book, wonderfully able as it was for the then state of knowledge, and to which Mr. Bourne was indebted for a great deal unacknowledged, and for formulæ whose identity was disguised by substitution of one set of letters for another, and which good taste at least would have referred to in other terms than as "a work chiefly made up of mathematical sublimities, which have but little relation to practice" (Bourne, Preface to first edition)—a statement very wide of the fact—had got into the late Mr. Weale's possession, and in the hands of that enterprising tradesman got stuffed out by additions (good, bad, and indifferent), until its costly obesity, and the utter trash of which much of that was made up, fairly put it out of the way as a rival. Few men who are competent to write a really good treatise on any such cumbersome, detailed, and specialized subject as the steam-engine, like the drudgery of compilation; and that is no doubt one reason why no good and exhaustive treatise of a recent date—always excepting Rankine's admirable volume, which, however, views things much more with the eye of theory than of practice—has appeared in English, though such are not wanted in French and German. From the confluence of these causes mainly, we interpret the fact that Mr. Bourne's work has reached its eighth edition, is no longer "under her majesty's patronage," but is now dedicated to the president of the Institution of Civil Engineers, as a personal testimony of respect and esteem from "the author."

Now we cannot help saying that his book has not grown better—like wine—as it has grown older; nor has it increased in wisdom, as it certainly has in bulk and stature.

The original edition consisted of 258 pages, all told. The volume now reaches to 489, or close upon 500 pages. The first edition all through stuck pretty closely to its text, however expounded; the eighth, that before us, consists, as respects its last eighty-two pages, of simple undiluted *padding*—mainly of such commonplace tables as are to be had in every pocket-book one lays hands upon; weights and measures, circumferences and areas of circles, squares and cubes, 4th and 5th powers, specific gravities, weights of bar and plate iron and other metals, equivalent columns of mercury and water, &c., &c., &c. the last ten pages having their square expanses stuffed with absolute chopped straw—Report on American goods locomotives; so-called "specifications" of English, Scotch, and American locomotives, and of a dredging machine; statistics of railways, and ending, of all things in the world, with "Faraday on the Conservation of Force!"

If this be useless lumber, for every purpose but that of the printer and publishers, it is at any rate innocuous to the reader. Let us see whether this be equally true of the 149 pages of intercalated matter by which the preceding 258 pages of the original edition have been swelled out to 407 in the present one. Here we are not so fortunate. The first forty-five pages consist of the preliminary matter of twenty-two pages in first edition, doubled in volume, and justly, so as to take in the later history of the engine, which now includes marine and locomotive engines, and traces well enough for the majority of readers, who care nothing for research and historic verification, the history of the steam-engine down to this present year of grace.

We, then, in Chapter I., launch out upon the scientific principles of the steam-engine. In the first edition this started with "mechanical definitions;" and oddly enough these commenced, or rather went on straight away for four pages, with tables of the density and temperature of steam, and of the areas of circles, &c.

Job had his opinion of what was "the beginning of wisdom;" but certainly the notion of the Mr. Bourne of that day upon what was the beginning of mechanical philosophy, was peculiar in thus starting; and not less so in some of the "definitions and properties of matter" which follow: "*Body* is the mass or quantity of matter contained in any material substance." Clear thinkers have defined *mass* to be the expression for the weight and volume of a given *body*. "Bodies are either hard, soft, or elastic; and they are also either solid or fluid." "A hard body is that which retains its figure unaltered, under every circumstance, refusing to yield to any force whatever." What an astounding body! but we will not go through these puzzled definitions; it would be unfair to criticise definitions of matter written twenty years ago—if indeed the properties of matter were themselves not deemed immutable.

However, in his eighth edition Mr. Bourne takes a higher flight, and beginning with matter and its properties, in which we are told that "every body must have size or volume, and the limit or termination of a body is a surface or a superficies, thus, *a dice*" (Sam. Johnson induced us to suppose that the singular of *dice* was *die*) "or cubic inch of ivory has for its superficies six planes, each measuring one square inch," an illustration equally apposite and profound; and in which, "whether matter be a real substance or an aggregation merely of centres of force," is discussed, and it becomes pretty apparent that it is no matter whether it is so or not, to one seeking to get a knowledge of how steam engines should be made; at any rate, he is not likely to come to a conclusion from what he is here told.

But we have more transcendentalism in the sub-chapters, that "matter is not a distinct entity," in which some of the few cloudy speculations that Faraday ever wrote are dished up, as though they had been well-laid foundations for physical philosophy. This goes on then to the third heaven of transcendentalism, in which "the cause of gravity," which Newton humbly left untouched, is settled to the author's apparent satisfaction, by the reproduction of an isolated fragment or two of the nonsense that Dr. Hooke wrote upon the subject.

Thus we flounder along through "the explication of light and gravity, and, in the third place, to the explication of magnetism," to "the hypothesis of molecular vortices," in which, to one not previously and extraneously acquainted with the subject, an utterly unintelligible sketch of certain papers of Rankine and Clausius on the dynamic theory of heat is attempted; and on to "the nature of mechanical power;" and thence, after four or five pages of mechanics, quite of the epoch of Dr. O. Gregory's treatise or Ferguson's lectures of seventy years back, at last come to the humble question of the "parallelogram of pressures."

And here an imaginary giant is raised up, to be exhibited smashed under the writer's clear and vigorous pen. "The doctrine of the parallelogram of forces, *as usually stated*, assumes that the velocity imparted to a body varies in an arithmetical ratio, as the power applied to move it, and this hypothesis is not correct." We quite agree to that; but should like to see any decent treatise on elementary mechanics, dating in this century, in which any such statement is to be found.

Then we plunge into—of all things in the world to be found here!—the gyroscope, about which enough is said to prove the writer's imperfect acquaintance with its principles, though not to make anything about it intelligible to anybody; and then, pass luminously from centrifugal and centripetal motions, and finding the centres of gyration and percussion to be introduced for the first time to variable motion in "falling bodies;" and thence pass through the pendulum, to find ourselves on the earth once more in "the mechanical powers," as to which a column or more is spent in showing up the mistake of those who affirm that power is gained by the lever, &c.

About page 64 we slip, in a half-unconscious way, out of this precious jumble of statics and dynamics and what not, all muddled up together without order, key, or sequence, and find ourselves entering physics, at the door of the nature and laws of heat. The *nature* of this we might have presumed settled by the "dark sayings" at page 48, on Rankine's molecular vortices; but no, the falling bodies and mistakes about the lever were only an interlude, and here we come to it again, in a bit of half a column, neatly darned into the new edition, in which we have catalogued the *names*—nothing more—of some of the chief writers on the dynamic theory of heat, or, as Mr. Bourne phrases it, *heat* and *power*, and get a glimpse of what Joule's equivalent means. Then we wade through many pages, in which conductivity and diathermancy, and other big and learned words, are mixed up with the nature and causes of smoke and the economic values of different coals. The chapter continues to the end, through several pages, with a perplexed and perfectly useless recapitulation of the very various and many now obsolete researches that have been made on the relations between the pressure and temperature of steam and vapours.

Chapter II., from page 89 to 119, professes to develope the general theory of the steam engine, under the grand title of "Investigation of the laws and limits of the motive power of heat." The actual performance consists of the tagging together something, in a more or less fragmentary way, of nearly every paper that has appeared in English for some years on the subject of heat as a mode of motion. We defy any human being, who should attempt it by the aid of this book only, to make head or tail of what here professes to be treated of, and which is, or ought to be, the very foundation or door cill to any systematic work on the steam engine. We must reluctantly add that, from the internal evidence afforded here and in many other places throughout the work, we derive strong doubts that Mr. Bourne himself has ever really understood or mastered the methods by which the theory of the steam engine, as one case of heat motors, has been evolved from the thermotics of the present day. If he has so, he has effectually muddled the clear wine of his new views by putting them into the old bottles and mixing them upon the patch-work system with the statements of the old editions. These, though in many respects faulty, were lucidity itself as compared with the hodge-podge of which nearly the whole book now consists, due to the interlarding and interpolation of new and too often useless matter with the old. Order, sequence, symmetry, are fairly abandoned. To take one instance only: at page 158, after a mass of tables of the *flow of water through pipes*, we have the resistance of ships treated of both foreign enough, some might say, to the steam engine, within the just limits of a treatise on that machine; but at page 381, Chap. X., we go back to the resistance of ships, fresh and in full wind, as if all before had been clean forgotten.

We have unwillingly pursued this criticism in detail; nothing short of doing so, to the very limited extent we have done, would have justified the unfavourable judgment that we have had to form of the work. We cannot afford space, however, to go with it further, and willingly avoid going through the catalogue of imperfect, or erroneous, or misleading statements which we have marked from the rest of the volume.

Let us, however, ask with all earnestness, what is the exact end and purpose of the monstrous muddled mass of mongrel mechanics and physics, which fills the first hundred and more quarto close-printed pages of this volume? *cui bono?* who is to be benefited by its reading? If it be assumed that this book is to begin at the creation, and destined for those who know nothing before, is to teach the reader his elements of mechanics and physics, preparatory to his entrance upon the study of the steam engine, then must we say its malconstruction is such that the youth who might unhappily be compelled to try and get his first notions from it would, as a theoretic mechanic—if he ever got any notions at all—be for life-long a feeble lamester, absolutely incapable of ever investigating anything for himself, and never sure, in however simple a matter, of his tottering intellectual footsteps. And again, if this has been Mr. Bourne's notion, of what possible use are the differentials which he lugs in by the neck, out of other men's papers, in season and out of season? what is the use, *e.g.*, of pages 96 to 99, in a foam with Rankine's formulæ as to heat, to a student who must be instructed that power is not gained by the lever, nor velocities, as represented by lines, to be compared with pressures represented by the same? Well then, let us take the other alternative—the work is for the learned, for readers only, worthy of the exaltation in style and matter of the author; then what is the use of the terrible muddle of the first 100 or more pages at all? nay, are they not worse than useless, for, notwithstanding the pretension with which they are written, and the splendid display of symbols and like "caviare for the million," do not these pages sorely tend to lower the author's work in the opinion of every competent theorist, nay, of every man with a very little, but exact, knowledge of elementary mechanics and physics?

We write with no ill or hostile feeling to the author, or to this or any of his other works. We should, however, equally fail in our duty as technical journalists, were we to pass it in silence altogether, or fail to let it be known to the engineers of other countries that, if such books as this reach an eighth edition in England, they must not conclude that it is because no one in England knows better. Great as is our need of education, primary and technical, in Great Britain, we have a few really good books upon the steam engine, one at least equal to anything that the Continent has produced. Mr. Bourne's volume is, we calculate, about six times as big as the one burly octavo in which Rankine has said his say, in an orderly, truly scientific, intelligible, and, to a man knowing his rudiments, instructive manner, as to the theory and practice of the steam engine. We should be glad were we able to say that the merits of Mr. Bourne's work are even inversely as its size compared with the other.

That there is a great encyclopædic gathering of facts as to workshop and such like practice, and many admirable copperplates in this work, is undeniable. Yet even amongst the illustrations the steady desire to *pad* and puff out is apparent in the reproduction of an immense number of woodcuts of movable and agricultural engines, locomotives, &c., most of which seem to our eye to have been simply taken as electros from the illustrated catalogues of the makers of these convenient but now tame and commonplace machines. The book, to most, will find its best use in lying on the shelves as a sort of index to turn to, to refresh memory where to look for information as to a special point, as it may now and then turn up. To study it, would appear to us impossible to the beginner, to the properly informed a matter of disgust.

We have said, and sincerely, that we are unwillingly thus severe. We cannot avoid, however, adding that if anything be calculated to provoke hostile criticism it is the incredible and overweening self-conceit that crops out at almost every page of this work. One may forgive, with a smile, the vanity of a mechanical author placing his own visage and autograph (dated) upon his frontispiece; but what can be said for the tone and the matter of the prefaces, here printed, to the three editions, ending with the last? What may be the bulk of the organ of self-esteem of the man who, with the seething whirl of the world's progress round him, declares here *he intends* to write "a new book that shall be a mirror of the best practice and opinion, of the moment, of all countries," and complacently adds, that "as only machinery of the first quality will be illustrated in this work in any detail, the fact of any engine being so illustrated will carry presumption of its excellence, *as it will show that in my opinion* it is superior to the others from which it has been selected." If this be so, it will eschew illustrations from agricultural engine makers' catalogues, and we can only say, we hope it may prove better in all respects than the work which it has been our unpleasing task here to review.

Intention has been followed by realization, it appears, for seven parts in all of this magniloquently heralded work have reached us since we first had Mr. Bourne's eighth edition. The result of looking through this, which was to transcend anything that had ever been heard of before, and admission to the pages of which was to give the *imprimatur* of the author's approval, and make the fortune of any engine-maker who was so far blessed, is to convince us that a more complete piece of "book-making" has never appeared even on that hackneyed subject, "the steam-engine."

These typical "examples of steam, air, and gas engines," which were modestly to deliver to an expectant and admiring world "the past, present, *and future* of engines for generating motive power," turn out after a seventh part has been reached, to consist of nothing but reproductions of what has been quite as well or better published elsewhere, together with what may be called a running commentary of self-assertion and laudation in the autobiographic form, of and by Mr. Bourne himself. How far the promise of admission to the sacred pages of this work, as the test and proof of sure and established excellence, has been fulfilled, may be learned from the very first plate of the very first part; the engines of the American *Dictator*, by Ericsson, having, if we are not much misinformed, ere this proved that they are not likely to dictate to marine engine-makers who know their business.

The appendix of this part consists of eight quarto pages, cogged bodily out of the *Civil Engineer and Architect's Journal*, &c., and of a purely superfluous attack upon Mr. Charles Wye Williams and his smoke-doctoring notions. In this Part I., too, are some autobiographic details intended to show that Mr. Bourne was the first introducer of liquid fuel to raising steam, by the use of coal tar, which we happen to be in a position to prove are very essentially misstated.

In Part II. we casually came upon the following choice morsel of word wisdom, but fundamental blundering in dynamics, which must have been expected from the "philosophy" parts noticed in "the treatise." The illustration is intended to be apropos of the screw-propeller and negative slip (p. 23); it proceeds, "And the action resembles that which takes place in a cannon, when, although the gas presses back the gun with the same force as it presses forward the ball, yet, as in consequence of its inertia, the gun moves only through a small distance in the time in which the ball moves through a great, *the vis viva accumulated in the ball is vastly greater than that accumulated in the gun*, and if extracted and utilized in any mechanical process, it will consequently go very much further, or produce very much more effect." The italics are ours. Need we comment on this? at least we will not trust ourselves to do so.

Then, on the "practical" side, we have, in Part III., p. 27, "Two separate locomotive engines run footboard to footboard" (a plan which, like nearly every other improvement in steam-engines during the last thirty years, is traceable to Mr. Bourne, by himself) "have *this manifest advantage* over Mr. Fairlie's Siamese arrangement, at all events, in the case of existing lines, *that they may be moved by the existing turntables*." The italics here also are ours. We have until now been under the belief that one of the most manifest advantages of Mr. Fairlie's engines was (and is) that turntables cease to be of any use, and are not wanted with them at all, as they run identically the same in all respects, whichever end be run foremost. After this *little* slip, we may form our own notions as to the mature consideration which locomotive engineering has had bestowed upon it by the author.

In Part IV. we have reprinted bodily, so far as we can see, the Reports of Mr. Masters on Boiler Explosions in 1866-67, as engineer of the Midland Boiler Association. As these Reports are circulated broadcast as "circulars" of the company or association, if we mistake not, and certainly have found their way into most of the mechanical periodicals in Great Britain, they do look out of place, as filling stuff for twelve pages of appendix, in a work of quintessential pretension to novelty and merit.

In Part II., p. 24, we are gravely told that "single-acting engines, even for pumping, are now *obsolete*"—a woudrous fact, if a fact, but one rather hard to reconcile with the illustration and description in the subsequent parts of this work, which declares itself to permit "nothing but the newest and best articles in its line of business" to enter its pages, of several of these obsolete single-acting engines.

Part VII. illustrates and enforces the irrepressible Gwynne's centrifugal pump, accompanied by some far more than doubtful statements as to the performance, &c., of centrifugal pumps. Blowing engines are blown to a larger dimension in type, here at least, by a purely irrelevant and unmeaning digression upon the performance of blast furnaces and the proportion of fuel to pig made in the Cleveland district; and the appendix to the part consists in the transfer bodily from the pages of the *Philosophical Magazine* of the English translation of a paper by Helmholtz "On Discontinuous Movements of Fluids," which has about as much to do with engine-making, theoretic or practical, as a dissertation on the domestic virtues of Moses' wife would have, and the only conceivable use of which seems to be to give an excuse for printing a lot of differential formulæ of Helmholtz, which shed a learned light upon Mr. Bourne's pages. If this be not book-making, what may that be?

THE REPORTS UPON THE GREAT EXHIBITION of 1867, at Paris, may now be viewed as almost, if not altogether completed, by the publication of the thirteen large octavo volumes of reports of the International Jury, by the French government, under the direction of M. Michel Chevalier. To attempt now to analyze here this vast mass of information is of course impossible. Generally we may state that the breadth and depth, and manner of execution, is rather markedly an improvement upon the later reports of former exhibitions. Several of the reports (the totality of which, of course, exhaust the whole of the classes) are of great excellence and by men of the highest mark; and although there are many others by little known authors, and to some of whom comparatively trivial subjects were necessarily assigned, the upshot is to present perhaps the very best, certainly the most complete, account of the exhibition that has yet appeared. This much was to have been expected. The work is not illustrated, but as it stands has involved a serious expenditure, and with much liberality the French government has presented copies to all those foreign jurors who are known as engaged in, or taking an interest in the improvements of arts and manufactures. The "get up" of these reports, though their binding is but in the usual style in France of paper covers, is in point of paper and type superb.

Some time before the French reports were ready, our own British commission, under the steady care and urging of Mr. Cole, had produced its six octavo volumes of reports, of which the first contains the general report, and tables of statistics of the exhibition; vols. 2, 3, 4, and 5, the reports on the classes, with the general index; and vol. 6th and last, the returns of the new French order of merit, adjudicated upon at Paris—a volume, we may remark, as dull, as the subject of this so-called order of merit is objectionable if not absurd, in English eyes at least. There are some woodcut illustrations in these reports, few of which evince as much pains on the part of the respective authors as could have been wished for, and, indeed, ought to be expected from any man who accepts the responsibility of a class reporter. Some few are conspicuously defective; that, for example, "On New Chemical Processes" is despatched, and by Dr. Lyon Playfair too, in three or four pages, and really leaves its great subject almost untouched. The British Commission acquitted itself at Paris in really good style, and it is with pleasure that we record the ability with which on the whole its difficult tasks were performed under the main direction of Mr. Cole, and we cannot but regret that those intrusted by him with carrying out this part of the work have not in all instances more worthily seconded him.

These British reports have been got up by the Queen's printers in the usual small octavo Blue book style, and as to the taste of that style, we cannot say much in its praise. Copies, we believe, have been presented to the British jurors, and, we presume, also to some at least of the foreign jurors.

Several of the continental nations have produced official or quasi-official reports, more or less complete, of what they witnessed in Paris. Of these one of the most exhaustive, well-illustrated, and complete, is that published under the auspices of the Imperial Royal government, by the Austrian central commission of the Exposition, in several volumes octavo, some of the earlier parts of which we have previously noticed in these pages. These reports are very carefully prepared, and by men who have devoted fully their attention and time to their respective tasks. The illustrations are both woodcuts and lithographs, and are of great accuracy and fullness.

Very recently we have received another ("Beobachtung über die Fortschritte auf dem Gebeite der Industrie und des gewerblichen Unterrichtes," &c.) being a collection of reports classified under subjects by between thirty and forty authors, who had been sent to Paris by the Austrian minister's sanction to report upon the improvements there shown, and whose work has been edited and brought together by Herr Leop. Fürstedler, ministerial concipist and Bibliothekverwalter des gewerbvereins of Austria (copyist and librarian to the minister for the Austrian Board of Trade, as we may translate it). These volumes are in several respects the very best and most suggestive reports we have yet seen, briefly passing by all except what is really important and novel, and noticing such with fullness and discrimination. They are especially valuable in relation to chemical products, and manufactures more or less resting on chemistry. In another line, though we can scarcely say in a lower one, we have the French reports produced by the enterprise of private speculation on the part of publishers, such as the "Visites d'un Ingénieur," the "Revue de l'Exposition de 1867," published in several octavo volumes by Noblet, Paris, and the "Etudes de l'Exposition de 1867," by Lacroix, Paris; both these embrace matter of abiding value, and their illustrations are very good. From the latter work we have given several samples in articles translated specially, which have appeared in our pages from time to time.

Besides all these there were published while the exhibition was still in being, two or three volumes by the French government, descriptive of the models, maps, plans, &c., exhibited by the Administration des Ponts et Chaussées, the ministry of marine, &c.; and by the several foreign nations a large mass of special volumes, each containing a more or less full account of their own national products, with statistic tables of education, industry, &c. One of the completest amongst these was that of the late government of Spain, and one of the most interesting to us, that giving a description of the Prussian system of lower and middle class school education. There have also been a considerable number of privately got up "brochures" on special subjects by manufacturers, inventors, and men of specialties in science or art.

Upon the whole, this Paris Exhibition of 1867 has been better and more fully described, and has left behind it a better and a more permanently valuable mass of literature, than any preceding one. That it is so is matter for congratulation; for without such a sequel exhibitions are not worth much more than mere big shows, for the amusement of the passing hour. For such of our readers, and they must be the large majority, as are interested in exhibitions of manufactures, &c., we have thought this notice must prove useful as a future index to sources of information.

Hints on Household Taste in Furniture, Upholstery, and other Details. By C. L. Eastlake, Architect, with 90 illustrations, of which 14 are printed in colours. Square Crown 8vo. London. 1869.

We opened this book expecting really to find some good sense and cultivated taste, combined into such a codified form, as might guide a large number of our well to do householders, who often show a want of both, into some much needed improvements upon the enormities which they and their tradesmen between them perpetrate, in the furnishing of houses. Such a work is much needed, and might do great good.

In this attempt, however, we have been greatly disappointed; it is about the most silly production we have met with under the signature of an architect, and, were such more common, might go far to justify the taunts and sneers, but too often and unjustly, levelled by the common sense engineer who hates taste, only when and because he possesses none—that architects as a body are mere creatures of precedent and followers of old routine, oblivious to all congruity and sense. The author here is devoured with mediævalism, and would mediævalize everything in the house, from the kitchen dresser to the basin stand in the attics. Some of his justifications for the adoption of the barbarities of mediæval construction in furniture—of which he produces illustrative designs, in themselves, to our eyes, of singular deformity, to say nothing of the utter incongruity of such things to our modern wants and in our houses of to-day—are, as types of what furniture ought to be, ludicrous in their feebleness. Need we say more than that the author objects to *all mitred joints*, whether in table tops or legs, in chairs, picture frames or in anything else, on the ground that that is a weak and false construction, and in place of it he teaches our table frames ought to be made with heavy lumpy tenons running right through, and with cross dowal pins outside to keep them in place! in a word, because in A.D. 1300 the carpenter's tools and his own skill were too rude to fashion anything else but such, out of the native grown timber he had to work up, into furniture as simple and heavy nearly as butchers' blocks, that so to-day the satin or sandal wood of India, the feathered mahogany of Cuba, and the exquisite hand skill, machinery, and refined tools that can produce a Broadwood pianoforte case, ought to be devoted to nothing better than to the designs, style, and finish of 500 years back.

Les Grandes Usines en France et a l'Etranger. Par Turgan. Grand 8vo. Paris. 1867-68.

The seventh and eighth parts of this very elegantly compiled work have appeared; and though, as might possibly have been anticipated from the extension of the original title, so as to include at will *all the grandes usines* in the world in fact, there are some little symptoms in the later parts of "bookmaking," still, up to the last part, the work fairly keeps to the promise of the earlier ones. The seventh part embraces an account of the ancient French national gun foundry, at Ruelle, for the fleet, but upon this, is in fact hung on, a popular account of nearly all that has been done of late years in great gun foundng or forging in every country. Much of the information so put together is necessarily of a very superficial and imperfect character, and though no positive mistakes have met our eye, the information is not unlikely to mislead here and there readers who have no other sources of information.

This is followed by an extremely interesting and picturesque account of the manufactories of *chocolate menier* of Noisiel, and of the foreign establishments in connection therewith, from whence the supply of the Theobroma bean is obtained; the agricultural establishment of La Briche; the jewelry works of Rouvenat; Leroy's manufactory of paper hangings, of world-wide fame; the silk throwing and weaving mills of Bonnet; the great glassworks of the Loire; the china manufactory of Gien. The marvellous nest of industry of the establisbments of Japy & Beaucourt, near the frontiers of Switzerland, where they make locks and clocks, and clock movements, and watch and clock screws, and wood screws, and ironmongery of divers kinds, and hollow ironware, and pumps, and no end of other such things, is one of the best accounts in the volume, which ends with the Forges et Chantiers de la Mediterranée at La Seyne, near Toulon, of which the account is meagre and incomplete.

The eighth part is not inferior to the preceding in interest. It comprises the great imperial marine engine factory at Indret, mouth of the Loire; eight successive articles descriptive of as many manufactories devoted to the preparation, manufacture, and dyeing of wool and woollen fabrics; the india-rubber factory of Guibal; the Gevelot works for preparing fulminating primings and cartridges; the small-arm works of the renowned Le Faucheux of Paris; the manufacture of waxed and water-proof tissues and fabrics; and the Pinet manufactory of agricultural implements at Abilly.

What a noble book of this same sort *might* be written upon the great establishments and industries of our own country by a really competent man, to whom the channels of information would be opened. Let us hope that no Mr. Smiles may get hold of such, as a taking bookselling speculation, and with puffy exaggeration and shallowness spoil that which might be a national as well as literary monument.

Œuvres d'E. Verdet. Publiée par MM. Prudhon et Violle. Paris, Masson. Grand 8vo. 1868.

A new volume of this system of physics, the first one of which we noticed some time ago, has appeared, though not in the regular numerical order. The first and second volumes of the general physics are now followed by vol. vii., which contains the *Lecons sur la Theorie Mecanique de la Chaleur*, delivered in 1862, by the late Professor Verdet, before the Chemical Society of Paris, combined with the notes taken by two of his pupils of their deceased teacher's "course" on the same subject, delivered in 1864-65 before the Sorbonne. Certain papers on the same class of physics, published by Verdet in the *Annales de Chimie et de Physique*, have been combined with the volume, the whole being placed in order by the editors, MM. Prudhon & Violle.

This volume, which like all the rest of the work can be had separately, is probably the most complete and lucid treatise upon the mechanical theory of heat yet produced. To go through it, or any other complete treatise on this subject, necessitates a knowledge of the higher mathematics; but even to those who must, as respects the demonstrations involving this, "skip and go on," the volume is capable of conveying the best information on thermotics in a very lucid and consequent form.

PRODROME D'UNE DESCRIPTION GEOLOGIQUE DE LA BELGIGUE. Par G. DEWALQUE, Professor, University of Liege, &c. 1 vol. 8vo., 441 pp. Decq, Bruxelles. 1868.

THIS volume comprehends a very clear and complete view of the geology of Belgium, in both its purely scientific and in its technically applied aspects. It is not accompanied by any geological map, the Belgian state map being throughout referred to.

As being so nearly opposite to our own south-eastern counties, the geology of Belgium possesses a special interest to the British geologist. It has a further one, to those engaged in British coal mining, in the strange dislocations of its coal measures. The most ancient rocks of Belgium are quartzites, &c.; the coal formation reposes conformably on ampelite and phthanite (of the French and Belgian schools), and on carboniferous limestone, but abuts in some places upon older rocks, such as the Belgian pudding-stones. The country, viewed with a broad glance, is in fact an outlier of the great central plain of Europe, and the mass of its formations, except the earliest, have been derived from the materials carried at divers epochs down the valley of the Rhine by that river, and by the ocean. One excellent point of this well arranged volume is the careful and copious references to authorities.

NOUVELLE THEORIE DES MINES, &c. Par F. P. J. PIRON, Capitaine en Première au Regiment du Genie, de Belgique, &c. 1 vol. 8vo. Mnquard, Bruxelles. 1868.

THIS is one of the works which come in pretty rapid succession from the Belgian press, and which do honour to the ability and advanced knowledge of the scientific corps of the Belgian army. The motto of this work upon explosive mines reveals fairly its scope, *La Theorie des Mines n'est qu'une question de travail mécanique;* and its issue is, that after a preliminary discussion as to the methods hitherto in use for calculating the powder charges for blasts and mines, and a general examination of the theory, &c., of gunpowder itself, the author arrives at formulæ based upon the admitted principles of *work*, of considerable simplicity and facility of application for the practical determination of such charges. To the theoretic mechanic the author's analysis of the forces and resistances called into play in such explosions, and his determinations of what he has aptly called the "molecular trajectories" of the dislodged, compressed, or vibrated, successive *couches* of the resistant mass, are of a good deal of interest.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

TIDAL FLUSHING AND SEWAGE UTILIZATION.

(To the Editor of the Practical Mechanic's Journal.)

SIR,—I think all must have come to the conclusion long ere this, that liquid manure is invaluable for all crops, be they root, grain, or grass; and at the same time it must have occurred to the mass, that there is only one crop, namely grass, that can be irrigated with sewage all the year round; likewise, if there are no other means adopted for utilizing sewage, there must be provided a sufficient breadth of grass meadows, so as to utilize the sewage in the summer months. A provision must be made in all schemes to run it into the sea, for no farmer would think of applying sewage to grain crops but at the time when the plants are young. So it becomes imperative to have a large tract of meadow land, or have some means of manufacturing a manure cheaply, with house garbage of all sorts, sewage, &c. It appears to me that many are hunting after the "philosopher's stone" in this sewage question. There are many interests at stake; there is the chemist, the farm irrigator, the manure manufacturer, and the board that looks after such matters in all well regulated towns. The latter, I have no doubt, endeavours to adopt the best scheme, and tries to make it a profitable speculation. No one will dispute such is very praiseworthy if the profits accruing from the sale of the manure, grass, &c., goes to reduce the poor's rate, then I consider no one would grumble by being taxed, to keep densely populated towns in a healthy condition with the water carriage system for the removal of sewage, and by that system alone. All plans have been tried and have failed. Water is the great scavenger,

Fig. 1.

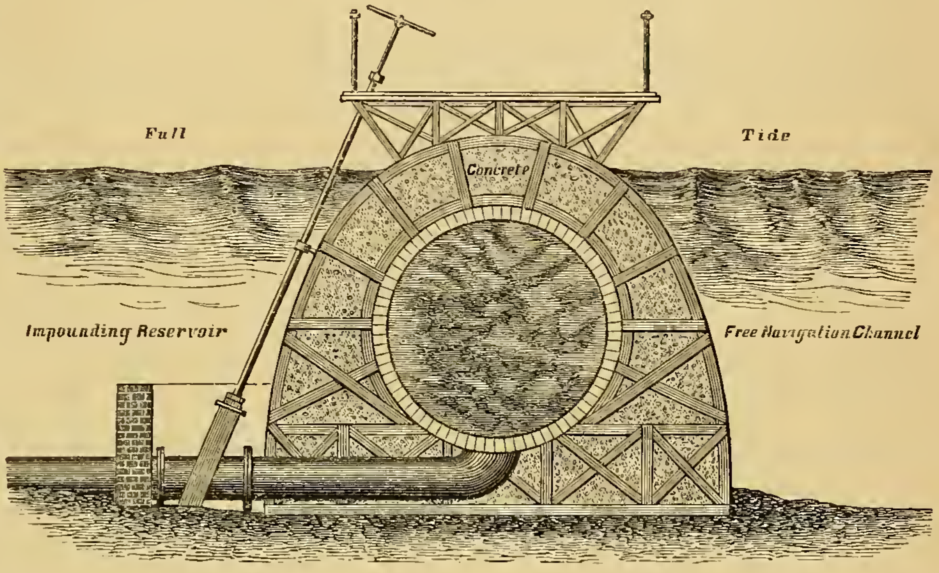
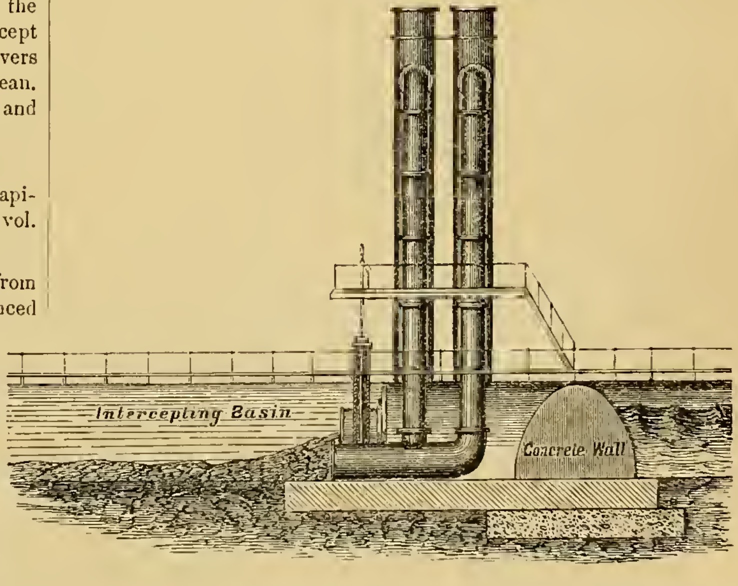


Fig. 2.



when dealing with filth in a wholesale manner: the more water the less the nuisance becomes, and *vice versa* is the commercial value of the sewage.

A town with sufficient altitude above a river, and having the means of forming an impounding reservoir, independent from the free navigation channel in the bed of the stream, with land on the banks to irrigate, or fields to manure, from the point we will say, that the sewage is conveyed from the high land intercepting sewer, as proposed for Glasgow, taking it away from the town under pressure, then all land from that point down to the outfall wherever it may be situated, can be irrigated, or the sewage conveyed to the manure manufacturer. Of course the best situation for carrying on the manufacture would be on the bank of the impounding reservoir, so that the partially purified water would flow into the reservoir and be flushed away at each tide. A letter in your last issue mentions the plan I have proposed for Glasgow. I take leave now to send you the rough idea drawn sufficiently accurate to scale. Fig 1 is the cross section of the collecting culvert, to be laid down to form the quay wall of the impounding reservoir; it is formed of wrought iron, lined with brickwork or flush plated, plastered over with cement, like the inner skin of steam vessels. There is an outer shell of wrought iron strongly united to the round internal tube, the space between being filled up with concrete. On the top there would be a pathway the outer length of this wall, and on the bottom sluices would be fitted, worked by a handle from platform; these sluices would be placed at convenient localities so as to suit the farmers and manure manufacturer. These tubes would be in convenient lengths, say 400 feet each, and with a means of jointing them together with an india-rubber ring, so as to swivel like a ball and socket joint, miles of this wall could be sunk in mass by this method; of course it is understood that at the fall of the tide the structure is left high and dry, so that the joints could be securely made. Fig. 2 shows part of the intercepting basin, the water formed in like manner quite solid, or filled up with concrete. It will be necessary to have a large sluice on the end of the great sewer, or culvert, so as to scour it out at times, and stand pipes must be fitted to a height that may be determined on. I have placed two such pipes on the top of culvert, having a smaller pipe on each side, connected to one discharge pipe at bottom; the object of this arrangement is to allow the sewage to flow away, and yet maintain the hydrostatic head, so essential in distributing the sewage on the farm and meadows, as likewise to the manure manufacturers. Thus a scheme providing for them all, with a means of impounding the partially purified fluid as it flows from the manufacturing depot and from the meadows, flushing it away at each tide, without interfering with the navigable channel, must surely satisfy the authorities of all towns as conveniently situated as Glasgow. Trusting you can grant space in an early impression,

I am, Sir,

Yours truly,

JOHN G. WINTON.

13 Gladstone Street, St. George's Road,
December 28, 1868.

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,— I have just completed the erection of premises for business, and have made provision for a crane outside the upper story, to lift goods; but I find the new bye laws of our town council do not allow cranes projecting in any of the streets. I therefore am obliged to resort to some other mode of lifting goods. I have not room in the upper story for a fly wheel or drum, or I prefer it. I do not see any way of doing but to fix a strong hook to one of the beams in the upper roof, and *take your advice* as to the *best and easiest apparatus*; it will be constantly in use, and will be required to lift from 10 cwt. to a ton. The ordinary block and pulley is such a slow process. The favour of your considering this matter for me, and replying in your next number, will greatly oblige.

I am, Sir,

Yours, &c.,

J. HUMMERSTON.

80 Albion Street, Leeds,
December 26, 1868.

[It is not quite within the province of a journal such as this, to bestow gratuitous advice on mechanical questions of practice. For once, however, we will depart from rule, as anxious to oblige one of our readers. Our advice then shortly is—Make your trap doors vertically under each other. Put a properly hipped transverse little roof, out from the existing roof of your building, giving you room enough for the ordinary drum and fly wheel or "sack tackle," as it is still called in Lancashire. Work by hand if you have not much to raise and lower; if otherwise, put up a small water-pressure engine (if your Leeds water supply is sufficient, as it is in Manchester, to work it), or if not a small gas engine, and with its own special meter. Lenoir's engines now are made to work as easily as a common clock.—Ed.]

(*To the Editor of the Practical Mechanic's Journal.*)

Sir,—From the article on "Improvements in the Manufacture of Enamelled Ware in Iron," we infer that you must be unaware of our manufactures. You state that in no instance has enamelled iron for street plates, &c., proved permanent. We have numbers of testimonials in our possession (copies of a few of which we beg to inclose) that convince us of the durability of our enamelled wrought iron. Some short time since we received a very satisfactory account from the Dutch government of a number of tide gauges that we had supplied three years previously; and, although they had been subjected to constant change of temperature, rise and fall of tide, &c., they were found actually as clear and perfect in every respect as on the day they were originally fixed. You also suggest the use of Siemens' gas furnace: we have been working these for our purposes for the last seven or eight years, and find them superior to any we have yet tried. We have arrived at such perfection with our enamel that we can insure its equal contraction and expansion with the metallic body. The average thickness of our enamel is about $\frac{1}{32}$ of an inch.

We should be glad to see your article on this subject extended, and shall be happy to supply you with any further information.

Your obedient Servants,

THE PATENT ENAMEL COMPANY.

Birmingham, 1*st January*, 1869.

Note.—We still believe it a fact that enamelled iron will not withstand the air, moisture, and sulphurous vapours of our coal-burning towns: examples of their destruction may be seen in abundance. Nor do we believe it possible for enamelled iron to withstand sea-water if its surface be in the slightest degree exposed to blows or to abrasion. We are glad to find that our suggestion as to the Siemens' furnace has been anticipated.—Ed.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

THE INSTITUTION OF CIVIL ENGINEERS.

November 24, 1868.—The Paper read was on the "Roman Rock Lighthouse, Simon's Bay, Cape of Good Hope," by Mr. John Frederick Bourne, M. Inst. C.E.

The object of this communication was to point out the causes of failure of the original structure, and to give an account of the mode of securing the tower against further injury.

The late Mr. Alexander Gordon, M. Inst. C.E., was intrusted with the design, and with the superintendence of the construction of the ironwork and lantern in England. The design was for a circular tower, 15 feet in diameter and 48 feet in height, of cast-iron plates, with a central column, 16 inches in diameter, as a well for the weight of the revolving machinery. There were eight plates in the circumference of the tower, and six plates, each 8 feet long, in the height. But to admit of the horizontal joints of each vertical set of plates breaking joint with those of the contiguous vertical sets, there were four plates of 4 feet high each and four of 8 feet each in the first and last sets of plates. The door-cill and level of the first floor were 24 feet from the foundation; the whole interior up to that level being intended to be filled in with concrete. If the building, as designed, had been skilfully and carefully erected, and filled in with good material, there was no reason to doubt that it would have answered the required purpose, and have stood well. But it failed, and was condemned as being dangerous.

The first cause of trouble, and which led to immense additional expenditure of time and money, arose from the lowest portion of the rock being chosen for the site, on account of its being more level. The next error was cutting the foundation pits too deep into the rock, for the purpose of getting as much solid core as possible for the inside of the tower. In order to give a core of 6 inches at the lowest spot, it was necessary to leave it 2 feet 9 inches high at the highest point; and as the groove was formed by blasting, for the sake of saving labour and time, the rock was much injured. Every sea of course filled the annular foundation pit, rendering it difficult to work. Two channels were therefore made, by blasting, one on each side, to allow the water to run off; and these channels were very annoying at a later period. It was found impossible to cut the foundation pit true and level, or so difficult that the attempt was abandoned; and the holding-down bolts were so imperfectly secured, that some of them drew when screwed up. Nor was the circle true in plan. Not only had the bottom flanges of the plates to rest upon uneven bearings. being wedged up in some places with blocks of teak, but they were forced, when screwed together, to take a form to which they were not cast. When the plates were tightly bolted together, and the concrete was filled in to its full height of 24 feet, the plates began to crack vertically in six different places, one crack extending 28 feet high; so that it became necessary to hoop the tower with wrought-iron hoops. In this condition the lighthouse was completed and was used for some time. The erection occupied five years, and the cost was stated to have been about £17,000.

The lighthouse was built by the imperial government, and the arrangement was that, when completed to the satisfaction of the colonial government, it was to be maintained and lighted by the colony. Owing to its patched-up state the colony refused to undertake its maintenance, and consequently a long correspondence ensued, when a proposal, made by the author, was eventually adopted by the Board of Trade, that the tower, as it stood, should be surrounded to the level of the first floor, a height of 24 feet, by a concentric ring wall of granite, 4 feet thick, with a backing between the wall and the iron plates of about 8 inches of cement concrete.

The arrangements for conveying the stones to the rock, for landing them there, and for setting them by means of a traveller running on a circle of fished railway bars fixed round the tower, were described. Copious extracts from the resident engineer's journal of operations were also given, from which it appeared that the foundation pit was cut by drilling holes, $1\frac{1}{2}$ inch in diameter, in concentric and radial lines, to the required depth, and breaking the pieces out with plug and feather. The bed was then dressed until it was perfectly true. The whole foundation was got out in two levels, the lower one not being so deep as the old foundation pit, or as the channels previously referred to. The journal shows that in 269 days after the work was commenced, in 1864, there were 102 days on which it was possible to do something on the rock, in $356\frac{3}{4}$ working hours, whilst in the same number of days in the year 1865 there were only 42 days when the work could be proceeded with, for $126\frac{1}{2}$ working hours. But the year 1865 was exceptionally bad. The number of hands employed, all told, was generally nineteen. The four masons and two smiths received 6*s.* 6*d.* a day each, and the labourers who were employed in drilling, quarrying, and rough dressing, and in pulling out to, and back from, and working on, the rock, received 4*s.* 6*d.* a day each. It was satisfactory to be able to record, that the whole work was completed without any serious accident to the men. No difficulty was experienced in filling in the old pit and gullies in favourable weather, with Portland cement mixed with very little sea-water and chips of granite from the quarry. A temporary protection for each short length of pit, as it was about to be filled, was made with gunny bags, filled some with sand and some with clay. As the stiff cement and flakes of granite were laid, they were covered with tarpaulin and bags. Some time elapsed, owing to adverse weather, before the courses of stones could be laid. The work was commenced on the lee side of the tower, and carried round to windward on both sides for the first three courses, after which each course was commenced to windward, as, being 6 feet high, it was not so much exposed to the force of the sea, and it was more convenient in bringing round the stones. By the end of 1866 the work was at its proper height for putting on the coping. This was completed early in the following year, when the lighthouse was taken over by the colonial government.

ANNUAL GENERAL MEETING.

December 22, 1868.—The report of the council stated that during the past session there had been twenty-three ordinary general meetings, at which the average number attending had been 244, while in the four preceding sessions the numbers were 155, 175, 192, and 208 respectively. At these meetings papers were read and discussions took place on various professional subjects. These included the benefits and expedients of Irrigation in India, Spain, and other warm climates, and on the proper construction of Irrigating Canals; the manufacture and wear of Railway Bars; the relation of the Fresh-water Floods of Rivers to the areas and physical features of their basins; on Floods in the Nerbudda Valley, with remarks on Monsoon Floods in India generally; on the Victoria Bridge on the line of the Victoria Station and Pimlico Railway; on New Railways at Battersea, and the widening of the Victoria Bridge: the City Terminus Extension of the Charing Cross Railway, embracing a description of the Cannon Street Bridge and Station; the Durability of Materials: the Supporting Power of Piles, and on the Pneumatic Process of sinking Iron Columns, as practised in America; and the Experimental Determination of the Strains on the Suspension Ties of a Bow-string Girder. Although the topics thus dealt with had been comparatively limited in number, yet it was believed they might be fairly regarded as representing some of the principal problems now engaging the attention of engineers. There was, for instance, probably no question of greater national importance, having regard to the interests and welfare of so many of the queen's subjects, than that of Irrigation. Hitherto the records of the Institution had been a blank upon this branch of engineering practice; while treatises on the subject, at least in the English language, had previously been almost entirely wanting.

For these communications various Premiums had been awarded, which were presented after the reading of the Report, including Telford Medals and Telford Premiums of Books to Messrs. G. Higgin, C. P. Sandberg, W. Wilson, C. D. Fox, J. W. Barry, and Lieut.-Col. O'Connell, R.E.; a Watt Medal to Mr. E. Clark; a Telford Medal to Mr. W. J. M'Alpine; Telford Premiums of Books to Messrs. T. Login, A. Wilson, and W. Airy; and the Manby Premiums of Books to Mr. A. C. Howden. It was noted that Mr. E. Clark had previously received a Telford Medal from the Institution.

With respect to the new building it was remarked, that as soon as it was determined to retain the existing site with the addition of the back part of an adjacent house, as recommended by the council, a lease was taken for 99 years of each of the two properties, for £450 per annum in the case of No. 25 Great George Street, with the option of purchase within ten years for £12,000, and in the case of the back part of No. 24 Great George Street for £208 13*s.* 4*d.* per annum, with a like power of making it freehold for £4161 13*s.* 4*d.* It was mentioned that the two sums last named were the net amounts which would have to be paid, after making allowance for the very liberal gifts of two of the owners, viz., the entire of Mr. G. R. Stephenson's interest of one-third, and £500 in diminution of Mr. Bidder's interest, also of one-third.

At the same time the specifications and contract drawings for the works were prepared with alternative conditions: one for their completion and delivery in five months, so as to be ready for the opening of the present session, the other for their performance in eight months. Tenders were received from several eminent builders, and that of Messrs. Holland and Hannen being the lowest, was accepted. That firm undertook to finish the building according to the architect's designs in five months for a sum of £11,650, and in eight months for a sum of £11,100. The contract was based on the first-named alternative, and had been duly fulfilled, in a substantial and satisfactory manner. In maturing the details of the plans of the new building several important modifications had been made, the principal being the addition of a newspaper and tea room on the ground floor, by which the area of accommodation for the general use of the members had been doubled, and the introduction of a glazed corridor on the first floor level—a further valuable concession granted by the owners of No. 24 Great George Street— by which it had been possible to provide four public entrances to the meeting-room, instead of two only as originally contemplated.

Time did not admit of the whole of the accounts in connection with the new building and its accessories being examined and settled prior to the close of the financial year of the Institution on the 30th of November last, so as to be included in one statement of expenditure. But the accounts had since been collected, so that the council were enabled to state that, whereas the estimated outlay, including all contingent expenses of moving, furniture, &c., amounted to £16,810, they fully believed the actual cost, including some furniture not yet delivered, would not exceed £17,250. To meet the liabilities thus incurred, the council decided to dispose of, in the first instance, the building fund, being the accumulations of fees received from members and associates on joining the Institution; next, to realise the unconditional bequests; and lastly, to sell so much as might be required of the investments made from time out of surplus income. The first two sources would of course be entirely exhausted, but as far as the council could judge, when every liability was discharged, stock would still remain in hand of the nominal value of about £3000, to provide for future contingencies. The Stephenson Bequest of £2000, the Miller Bequest of £2000, the Errington Bequest of £1000, and the Locke Bequest of £2000 would hereafter disappear from the accounts, but the names of these benefactors would be held in grateful remembrance as connected with the erection of the new building.

A notice had recently been served on the Institution, that application was intended to be made to Parliament in the ensuing session for an Act, under the title of "Public Offices Concentration (Acquisition of Lands)," to empower the Commissioners of Her Majesty's Works and Public Buildings to acquire the property held by the Institution. The council had, in reply to this notice, intimated their dissent to the proposed undertaking

The council having decided to institute an inquiry as to the systems of Engineering Education (other than Military Engineering) in different countries, the cost to the students and to the respective governments, and the effect, or presumed effect, of such preparatory training upon the profession, had addressed a circular letter to numerous technical establishments and private individuals abroad and at home. This circular had been very fully responded to, and the result had been the receipt, quite recently, of a mass of materials which yet remained to be arranged, but which it was hoped would in due time be presented to the members. While on this subject reference was made to the munificent foundation, in perpetuity, by Mr. Joseph Whitworth, M. Inst. C.E., of thirty scholarships, of the annual value of £100 each, as to which a communication was brought forward from the council at one of the ordinary general meetings last session, and was adopted by acclamation.

During the past session 45 members and 105 associates had been elected, while the deceases, resignations, and erasures together amounted to 34, leaving an effective increase of 116, or at the rate of 7·41 per cent. on the present number of members of all classes. This rate of increase had only been exceeded in the years 1865 and 1866, and had not been nearly equalled in any other year except 1867, when there was an increase of 7·02 per cent. There were on the books on the 30th of November last, 16 honorary members, 637 members, and 896 associates, making a total of 1549, exclusive of students. The admissions to the class of students, which had only been in existence one session, had amounted to the same date to 133.

The deceases announced during the year had been:—Sir David Brewster and Lord Brougham, Honorary Members: George Rowdon Burnell, Alexander Gordon, Daniel Gallagher Grose, George Alfred Jermyn, Michael Lane, George Holsworthy Palmer, Thomas Rhodes, and William Swinburne, Members; Henry Goulburn Anderson, Thomas Long Colley, Isaac Curran, Andrew Henderson, Peter Hogg, Frederic Cornell Reynolds, Robert Sharpe, Francis Adolphus Smart, Thomas Hitchin Smith, William Strode, William Swann, and John Vaughan, Associates.

In reference to the financial position of the Institution, it was shown, by the abstract of accounts for the year ending the 30th of November, 1868, that the income proper, exclusive of all receipts from life compositions, building fund fees, and dividends of every kind, had amounted to £5633 3*s.* 3*d.*, while the ordinary disbursements had only been £3667 4*s.* 8*d*, thus leaving a surplus of £1965 18*s* 7*d.* But when to this sum was added the above excluded items, still disregarding all trust monies, the surplus became £3210 8*s.* 6*d.* In the early part of the session a sum of £1250 was invested in the purchase of £1344 1*s.* 8*d.* new three per cents. After it was decided to proceed with the new building, Mrs. Locke's special donation of £200 was paid into the general account, and subsequently the treasurer received, from the Court of Chancery. the Locke Bequest of £2000. As the works of the new building proceeded, it became necessary to dispose of stock to meet the architect's certificates, and the amount of stock so sold had up to the present date produced £10,246 1*s.* 8*d.*, with a loss between the purchase money and the sum realised of £168 6*s.* 10*d.*

The nominal value of the realised property belonging to, and under the charge of, the Institution, consisted at the 30th of November last of:—1. General Funds, £12,056 1*s* 8*d.*, and 2. Trust Funds, £12,119 15*s.* 11*d.*, making, together with the cash balance of £1232 14*s.* 10*d.*, a total of £25,408 12*s.* 5*d.* as against £29,633 16*s.* 2*d.* at the date of the last report. This represents a decrease of £4225 3*s.* 9*d.*, but it was to be remarked that in the period referred to a sum of £9711 16*s.* 10*d.* had been paid on account of the new building.

In conclusion, the council stated that they had much pleasure in submitting this narrative of their administration during a period of unusual responsibility, and they hoped their labours had been attended with advantage to the Institution.

The thanks of the meeting were unanimously accorded to the president for his zealous efforts in the interests of the Institution; to the vice-presidents and the other members and associates of council for their co-operation with the president, and their constant attendance at the meetings; to Mr. Bidder and to Mr. G. R. Stephenson for their very liberal contributions in aid of the new building; to the architect for the skill shown in the design of the building, and to the contractors for their energy in carrying it out; to Mr. Charles Manby, honorary secretary, and to Mr. James Forrest, secretary, for the manner in which they had performed the duties of their offices; as also to the auditors of the accounts, and to the scrutineers of the Ballot, for their services.

The following gentlemen were elected to fill the several offices on the council for the ensuing year:—Charles Hutton Gregory, President; Joseph Cubitt, Thomas Elliot Harrison, Thomas Hawksley, and Charles Vignoles, Vice-Presidents; James Abernethy, William Henry Barlow, John Frederick Bateman, Joseph William Bazalgette, Nathaniel Beardmore, Frederick Joseph Bramwell, James Brunlees, George Willoughby Hemans, John Murray, and George Robert Stephenson, Members; and M.-General Sir W. T. Denison, K.C.B, and Frederick Ransome, Associates.

January 12, 1869.—The paper read was "On Coal Getting Machinery, as a Substitute for the use of Gunpowder," by Mr. C. Chubb.

It was remarked that the improvements now needed in the art and practice of coal-mining might be thus specified—first, to insure greater safety to the men employed in working; and, secondly, to obtain the coal in better condition, and, by preventing as much as possible the loss arising from waste, to make more fully available all the remaining resources of the coal-fields. It was contended that the use of gunpowder and the operation of blasting must be altogether abandoned; and the problem to be solved was, what force could be applied which should be equally effective, and at the same time break the coal in a more perfect manner. The author thought some more simple and practicable means of getting coal by mechanical power could be devised than the costly, but skilfully contrived, coal-cutting machines. His first idea was to apply wedges, acted upon by hydraulic force, but he was induced to abandon that system, owing to objections to the use of wedges, and to adopt instead an apparatus consisting of twelve plungers, set side by side in a steel bar, which plungers, when acted upon by water from a hydraulic pump, would separate the bar in which they were set from another bar, formed in the shape of a cover upon the plungers. The pressing apparatus was 25 inches long, and it was attached to a hydraulic pump by a tube 2 feet in length, so that it might be inserted into the coal to a depth of about 3 feet 6 inches. The apparatus, with the cover on, was 4⅜ inches in diameter. When, by the action of the pump, the plungers had reached their limit of 2¼ inches, and further expansion was needed, the plungers were readily brought back to their first position, by opening an escape cock for the water, when a lever could be inserted between the plunger and the cover; and this process could of course be repeated. In practice, however, it was found that the first expansion to 2¼ inches was more than sufficient. It was stated that the collective area of the plungers was 24 square inches, and as the pump could exert a pressure of 12 tons on the square inch, a total pressure of 288 tons could be brought to bear on the coal.

This apparatus had been tried in the South Wales district, where the coal was of the most varied description. It was observed that by the present system of blasting, it occupied, on an average, two men ten hours to break down and fill into trams 4 to 5 tons of coal, of which 20 per cent. was "small," and the remainder much shattered. On the other hand, with this apparatus, two men could readily break down 20 tons in one hour, which could be filled, when loosened, at the rate of 10 tons per man per day, the whole of the coal so obtained consisting of large solid pieces. Again, by the present system, in order to break down 500 tons of coal a day, from a "four-foot" seam, a "face" of 600 yards was required, whether as "pillar and stall," or as "long work;" whereas with this apparatus the same quantity could be worked from 300 yards of "face." In this way there would be less space requiring to be ventilated, the working operations could be concentrated, and facilities would be afforded for effecting economy in other respects.

The discussion was then resumed upon Mr. Bidder's paper in conjunction with Mr. Chubb's, and not being concluded, it was announced that it would be continued at the next meeting, when, time permitting, the following paper would be read:—"On New Ferry and New Brighton Piers," by Mr H. Hooper, Assoc. Inst. C.E.

At the monthly ballot, the following candidates were balloted for and duly elected: as Members, W. Anderson and F. W. Kitson; as Associates, C. J. Clarke, E. N. Clifton, T. Dyke, R. M. Greene, T. Hennell, A. H. Kessner, F. L. O'Callaghan, W. W. Phipson, L. W. Pritchard, W. Stevens, W. H. Treverton, and M. Vidler.

A report was brought up from the council stating that, under the provisions of section iv. of the bye-laws, the following candidates had been admitted students of the institution since the date of the last announcement: J. Addy, J. Baumann, J. Brunlees, A. G. Fowler, A. C. Robson, R. Sharland, G. Stevens, and J. J. Stiles.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

ON WAR ROCKETS.

By James Nasmyth, C.E., Corresponding Member of the Society.

Under the impression that the improvement suggested in the following remarks on the above-named subject may lead to important results when carried into effect, I have ventured to solicit the favour of the attention of the members of the Manchester Literary and Philosophical Society to the subject, in the hope that it may interest them, and by their kind favour be recorded in their transactions, and so place the suggested improvements in question at the service of the public.

The valuable properties possessed by rockets as implements of warfare are so great, that could precison of flight be added they would rise to a position of the highest importance as destructive agents.

The comparative lightness and portability of rockets, and the fact of their combining gun, charge, shot or shell, all in one and the same projectile, together with their alarm-producing and highly destructive properties, has (notwithstanding their wildness or uncertainty of flight) caused them to be employed in warfare, in many instances with most effective and important results.

It is with the object of giving to such rockets all the advantages of rifle action, and so securing precision in their flight, that I desire to suggest means for effecting that important object by an agency that appears to me to be at once simple and effective.

Before proceeding to describe the means whereby I propose to effect the object in question, I would premise that what constitutes the true rifle principle in a projectile is not only the condition of axial rotation in the line of flight, but, above all, is the condition that the projectile possess the highest degree of axial rotation *from the first instant* of its forward course.

Unless this latter condition be present, no subsequent axial rotation, be it ever so great, can correct a bias or unprecise flight *after* the flight has commenced.

The grand desideratum to be sought for is, that at the instant the rocket commences its flight it shall possess the highest degree of axial rotation. With such conditions present, we shall confer on our rocket all the properties (as regards precision of flight) of the most perfect rifle projectile.

It is difficult by words alone to convey a perfectly clear idea of the mechanical arrangement by which I propose to effect this desirable object. I have therefore accompanied these remarks with an illustrative diagram of the mechanism by means of which I propose to confer on the rocket the requisite degree of high axial rotation, so that, like a true rifle projectile, it shall possess that indispensable condition of precision of flight from and at the very instant it sets out on its course.

Before proceeding to describe the distinctive features of my contrivance for effecting the object in question, it may be as well to allude to the means that have been employed in the endeavour to secure to war rockets rifle action or precision of flight. These consist in placing the rocket in a -shaped trough, by which the direction and inclination of the rocket is suitably secured previous to commencing its flight, and so far holding the rocket fair in the direction of the object aimed at.

Besides this an endeavour is made to give the rocket axial rotation during its flight by causing the propulsive gases, while issuing at the rear of the rocket, to rush through skew holes. This latter arrangement does, to a certain extent, give to the rocket axial rotation. But as axial rotation given by such means does not come into effective operation until the rocket has proceeded a long way on its course, it comes into action *too late* to have any influence in securing precision of flight.

In order, then, to effect our object I place the rocket inside a tube (into which it slides freely); to this tube, which serves to secure the aim of the rocket, I give, by mechanical means, an axial rotation of some thousands of revolutions per minute, which is transmitted to the rocket then resting within it.

The rocket, while thus revolving on its axis at the high velocity above named, is then fired, and so rushes forth from its guide-tube impressed with all the conditions of a perfect rifle projectile, and, as such, with every condition present that can secure its reaching the object aimed at.

Reference to a diagram which accompanied this paper will enable anyone to obtain a clear idea of the mechanical means and arrangements by which I propose to effect the object in question.

It consists of a suitable iron stand, supporting the rocket and its guide tube, the guide resting on loose friction wheels, which, while preserving with the utmost exactness the direction of the axis of the guide tube and rocket, permits the guide tube and rocket to revolve on its axis with all due facility.

The requisite amount of axial rotation is conveyed to the guide tube and thence to the rocket resting within it, by means of a powerful clock spring, transmitting its rotation to the rocket through a train of wheels.

Previous to firing the rocket the wheel is locked by the catch or trigger; the spring is then wound up and the aim and elevation of the rocket adjusted. The match of the rocket is then lighted, and in order to secure energetic combustion of the rocket ere it is allowed to rush forth on its course, the rocket is held in check by three slight springs within the guide tube at the rear of the rocket, by means of which it is not permitted to rush forth until the proper energy of discharge of propulsive gases has been acquired. As soon as this is the case the rocket frees itself and then rushes forth impressed with and possessing every condition of a true rifle projectile combined with all those important properties which rockets possess as implements of warfare.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.

The sixteenth annual meeting of members took place on Saturday, the 22nd ult. It was exceedingly well attended, and the chair was occupied by Mr. J. Newton. The first business of moment consisted in the presentation of the balance sheet of the last half year, and the report thereupon of the auditors—Messrs. Irvine and Bulleugh. From these documents we gather that the association, in spite of the continued depression of trade, is in a satisfactory condition, numerically and financially. The number of ordinary members is 104, and of honorary members, 64; total, 168. The general fund, invested or in hand, amounts to £429 2*s.* 11*d.*, and the superannuation fund (the interest upon which only is available for the partial support of decayed foremen) equals £903 18*s.* The fund for the solace of widows and orphans is very minute, amounting to £10 only. It is subscribed to homœopathically, to all appearance, by ordinary members solely. During the past year £103 were paid to unemployed associates, and £33 as solatia to the families of those who died in the same period.

The balance sheet and report were, after some discussion, unanimously accepted. Mr. Briggs having explained the nature and agreeable results of his visit to the Leeds Association of Foremen, which, too, is in a thriving condition, Mr. Newton proceeded to deliver the president's annual address. This was of considerable length, and of much interest, but it is not possible for us at present to give it *in extenso*. After alluding to the gratifying fact that the institution is steadily progressing, and gaining more and more the countenance and support of employers, Mr. Newton furnished biographical sketches of Messrs. Tomlinson and Clark, two associates, whose deaths occurred in 1868. Mr. Tomlinson was foreman of boilermakers at the Royal Dockyard, Woolwich; and Mr. Clark, foreman of moulders to Messrs. Maudslay, Sons, and Field. Details were given of their professional careers, of their personal characteristics, and of their scientific acquirements. It was (observed the president) a matter of regret that the materials for these biographies were scanty, although it was known that both associates had passed through many vicissitudes. "Were we one and all to keep diaries, and make careful note of our labours, our cares, our hopes, our fears, our disappointments, and of our triumphs over difficulties, what interesting and valuable memoirs might not be written, by kindly hands, of the foremen engineers?"

Turning next to the association itself, the president reviewed its proceedings in the past, and indicated what he considered should be its course in the future. The early efforts made for its establishment had been well sustained by its founders, and the institution was at that moment healthy and vigorous. Energy and activity, however, on the part of every member were essential for the promotion of its future prosperity. Apathy was the evil to be contended against; the rock ahead which must be removed. "Let but the intellectual strength and the practical knowledge of the associated foremen be put forth and developed in the lecture room as they were in the factory, and their society would take a high place in the estimation of scientific men of every grade. From a knowledge of the materials of which the association is composed, I am inclined," said Mr. Newton, "to predict that a day will come when the affixing of the initials F.E., as constituting membership, will entitle those who use them to an amount of consideration second only to that accorded to the C.E. and the M.E. It rests with members themselves to achieve this elevated position for the association."

The necessity of increasing largely the facilities for technically instructing youth intended for the workshop was dwelt upon with much emphasis, and at considerable length, and Mr. Newton concluded his remarks by thanking members generally for the uniform kindness he had experienced on all occasions at their hands. His tenth year of office had now expired, and, as an old hand, he trusted he might retire into private life with a "fair" certificate. Retirement, however, was not allowed to the president on this occasion, for Mr. Newton was at once re-elected to the office on the motion of Messrs. Hosken and Keyte, the two oldest members. Mr. Keyte was re-chosen as vice-president; Messrs. J. Irvine, Cutler, and Dewer were appointed members of the committee; and Mr. Edmonds, of Woolwich Arsenal, was elected as auditor for the ensuing half year. With a vote of thanks to Mr. Newton for his address. the business of the evening came to a close.

We have since learned with much satisfaction, that Joshua Field, Esq, C.E., has consented to preside at the anniversary banquet of the association on the 20th of February.

PHILOSOPHICAL SOCIETY OF GLASGOW.

ON THE RECOVERY OF SULPHUR FROM ALKALI WASTE.

By Mr. Ludwig Mond.

Continued from p. 317.

Sometimes the latter may be used very advantageously to increase the yield of sulphur without going to increased plant and labour. Water being brought in contact with these heaps, as is often done by nature in the form of rain or ground water, dissolves out yellow liquors, which contain principally sulphydrate of calcium and very little polysulphide. These may be mixed with liquors rich in hyposulphite, or they may be used in lieu of water, as has been preferred by Messrs. C. Tennant & Co., to lixiviate the oxidized waste, which in this case is of course to be oxidized so as to contain more hyposulphite than usual.

By these means the amount of recovered sulphur has been increased to fully three-fourths of the quantity contained in the waste treated by my process. Where muriatic acid is scarce—which, however, is very seldom the case where it is properly economized—the waste liquors from the manufacture of chlorine, containing free hydrochloric acid, free chlorine, perchloride of iron, and chloride of manganese, may advantageously be used for the separation of sulphur, as has been pointed out before me by Messrs. Townsend and Walker. This mode of working is exactly as with muriatic acid.

The free acid, the free chlorine, and one-third of the chlorine present in the form of perchloride of iron, are thus utilized, and the mixed liquors, containing principally chloride of calcium, and manganese, and protochloride of iron, are colourless and comparatively harmless.

Thus a second waste and offensive product can be advantageously disposed of.

The sulphur obtained is, however, in this instance not very pure, containing some sulphide of iron, and does not settle so readily as when made by muriatic acid.

With regard to the theoretical part of my subject, I am very sorry not to be able to give you a satisfactory account of all the reactions taking place at the different stages of my process.

We have to deal with a class of bodies, the polythionic acids, which have, for some unaccountable reason, been very little studied, though they certainly promise very interesting results of great value to theoretical chemistry.

They yield so little to the theories put forth of late years, which, being principally based on our increased knowledge of organic bodies, have left many well-known facts of inorganic chemistry unexplained, that I prefer to use old equivalents in explaining to you the few facts which I have been able to ascertain, as these will allow the reactions to be represented by simpler formulæ. I regret very much that my time has never allowed me to enter this subject *as fully as I should have wished to do.* Like most manufacturing chemists, being engaged in business, I could not attend to sincere theoretical work. I believe, however, that my process, though still very young, is not in respect to the theoretical questions involved in it worse off than its elder brethren, taking into consideration that our knowledge of the theory of our most important manufacturing processes is still very incomplete, and indeed amounts to very little more than the fact, that the substances which we produce have been contained in the raw material used, while we know so very little of what the manufacturer really wants for his guidance—viz., the different stages through which those raw materials go—that we must mostly depend on practical experience alone in conducting those processes. You may perhaps believe this statement to be exaggerated.

Leaving, however, the processes of destructive distillation of organic substances so largely employed for manufacturing purposes, and the manufacture of cyanides and ferrocyanides, out of the question, I will only refer to the manufacture of ultramarine (of which we do not even know the formula), to the chamber process for making sulphuric acid, and to Leblanc's method for the production of alkali, the different stages of which are by no means satisfactorily established, as a few illustrations of this fact. This state of things is certainly astonishing at a time when our science has made such rapid progress in every direction; and I cannot help thinking that scientific men must look with a sort of contempt upon researches on manufacturing processes—as I cannot otherwise explain, that out of the hundreds at present working in every branch of the science, so very few take up these important questions, but prefer to employ their time to prepare all possible salts of a new element, or to study innumerable homologues of a series of organic compounds.

Returning to our subject, we have, in the first place, to consider the action of air and moisture on alkali waste. The principal constituent of the waste is a compound of calcium and sulphur, insoluble in water, the exact composition of which is still a matter of dispute—some considering it as oxysulphide, others, simply as monosulphide of calcium.

I have not been able to form a definite opinion on this question; as both would, however, behave in the same way, it is simpler for our purpose to take the latter view.

CaS in contact with HO is converted into $CaHS_2$ and $CaHO_2$. This reaction, which goes on very slowly in the cold, is accelerated by the heat evolved during the oxidation of the waste; the carbonic acid of the air, with CaS, also forms $CaHS_2$ and $CaCO_3$.

The oxygen of the air oxidizes the CaS to CaS_2 and CaO, the latter of course combining with the water present, in moist waste.

At an early stage of a slowly-conducted oxidation, we thus obtain liquors from the waste containing nearly only CaS_2 and $CaHS_2$.

Continuing the action of air, or forcing it through the waste at a greater speed. the $CaHS_2$ is oxidized into HO and CaS_2, and the CaS_2 formed both by this and the above-mentioned reaction is further converted into CaS_2O_3. This latter compound decomposes readily, when exposed to an elevated temperature, into S, and $CaSO_3$, which is very insoluble The sulphur thus separated is taken up by the CaS_2 in the solutions, forming polysulphide, which again dissolves $CaHO_2$ out of the waste, forming with it compounds only sparingly soluble, which sometimes separate from the liquors in beautiful crystals. Forcing air at a moderate speed through a certain height of waste in a vat. all these reactions will take place at the same time in different places, and the liquors obtained by lixiviating after certain periods of exposure, will contain the substances named in quantities proportionate to the time of exposure. By forcing the air rapidly through the waste, and for a greater length of time, the CaS_2 will be nearly all converted into CaS_2O_3, and thus liquors are obtained very suitable for the preparation of hyposulphites. By going still further, the CaS_2O_3 will completely decompose into $CaSO_3$ and S. The former will rapidly form $CaSO_4$, with the evolution of a considerable quantity of heat, which will cause the sulphur to take fire and burn to sulphurous acid, which partially escapes. The temperature being once so elevated, the CaS, which remained so far unoxidized, is converted rapidly into $CaSO_4$, and the heat in the waste thus rises sometimes so far as to make it red-hot. You will see from these reactions that the prolongation of the exposure to air over a certain limit will cause decomposition of soluble sulphur compounds in some parts of the waste at first, and will gradually turn them altogether into sulphate of lime, which would make them lost for our purpose. Removing them, however, at a proper time prevents this loss to a great extent, and enables us to treat the waste repeatedly with the same result. So far I have, however, not been able to prevent the oxidation of a part of the CaS into $CaSO_3$ and $CaSO_4$, and this is the reason why I cannot recover all the sulphur which the waste contains, by my method. I have, however, no doubt that, with a few years' more practical experience, the process will in this respect yield better and better results, as has been the case with every other manufacturing process known.

The sulphur liquors contain, as already stated, according to the time of exposure and the pressure of the air, varying quantities of CaS_2O_3, CaS_x, $CaHS_2$, and CaO, HO, besides a trace of $CaSO_3$, and $CaSO_4$, which are, however, both so insoluble (in 800 and 400 parts of water respectively) that they hardly deserve to be noticed. It is of great importance to ascertain the relative quantities of the first-named constituents, as the oxidation must be regulated accordingly. I have found no means to ascertain the quantity of CaO, HO in these liquors, as in presence of $CaHS_2$ it behaves exactly as CaS. As it, however, plays the same part during the decomposition of the liquor, it makes no difference to our purpose to determine and calculate it as present in this form.

The hyposulphite is determined, as usual, by a standard iodine solution and starch, after having precipitated the sulphides by a salt of zinc, and filtered. Another portion of the liquor is tested by the same iodine solution and starch, until the blue colour appears. It is then again decolorized by a drop of hyposulphite of soda solution, litmus is put in, and a standard caustic soda solution is added until the liquor remains blue. The addition of acetate of soda makes the end reaction of this process very distinct.

The following reactions take place:—

$$2\ CaS_2O_3 + I = CaI + CaS_4O_6$$
$$CaS_x + I = CaI + x\,S$$
$$CaHS_2 + 2\ I = CaI + 2\ S + HI$$
$$HI + NaO = HO + NaI.$$

As you will readily see from these equations, the iodine used for the first test shows the calcium present in form of hyposulphite; the caustic soda, the calcium present in form of sulphydrate; and from these and the total iodine used, the calcium present in form of polysulphide is easily calculated.

The latter containing generally only little more than 2 equivalents of sulphur to 1 of calcium, the test may be as well applied to ascertain approximately the amount of sulphur present in the liquor. In separating sulphur from these liquors in the way before described, and carried out in your presence, though the final result of the process is so very simple—

$$CaS_2O_3 + 2\ CaS_x + 3\ HCl \text{ forming } 3\ CaCl + 3\ HO + (2 + 2\,x)\ S,$$
$$\text{and } (2 + 2x)\ S, \text{ and}$$
$$CaS_2O_3 + CaHS_2 + 2\ HCl \text{ forming } 2\ CaCl + 3\ HO + 4\ S;$$

there are very likely all possible compounds of hydrogen, oxygen, and sulphur, from HS_5 to HSO_4, formed in different parts of the vessel, and at different stages of the process.

I have been able to ascertain the presence of all those of the compounds named which our present knowledge allows us to recognize in presence of the others—thus, HS_5, HS, HS_2O_3, HS_3O_6 HS_5O_6, HSO_3 and HSO_4. Of the two missing ones, HS_2O_6 and HS_4O_6, we have at present no reactions which would allow their presence to be ascertained when mixed with the others. The formations of HS_5 and HS, by bringing in contact CaS_5 and $CaHS_2$ with HCl, is obvious to every one. It takes place only in starting an empty vessel, and then the HS_5 is often seen floating on the top of the mixing liquors. The formation of HS_5O_6 very likely takes place by the direct decomposition of CaS_2O_3, as Chancel and Diacon have directly obtained it by decomposing BaS_2O_3 with HSO_4 ($5\ CaS_2O_3 + 5\ HCl = 5\ CaCl + 2\ HS_5O_6 + 3\ HO$). The HS_3O_6 is formed by the following equation:—

$$5\ CaS_2O_3 + 3\ HCl = 3\ CaCl + 3\ HO + 2\ CaS_3O_6 + 4\ S.$$

These I found to be the principal products of the decomposition of CaS_2O_3 and HCl at a temperature of 140° to 150° Fahr. On boiling, or by standing for a number of hours, the CaS_3O_6 decomposes into $CaSO_4 + S + SO_2$ which accounts for the large quantities of gypsum obtained by decomposing liquors very rich in CaS_2O_3.

If, in this latter case, the muriatic acid is poured into the liquor gradually, the SO_2 thus formed converts the CaS_2O_3, still present, again into CaS_3O_6 (2 CaS_2O_3

$+ 3\ SO_2 = 2\ CaS_3O_6 + S$), and this is again decomposed into $CaSO_4 + S + SO_2$, so that the end of the reaction would be very nearly

$$3\ CaS_2O_3 + HCl = CaCl + HO + 2\ CaSO_4 + 4\ S.$$

This accounts for the difficulty which I found in obtaining sulphurous acid in quantities by decomposing hyposulphite of lime by means of muriatic acid. In my present mode of working, however, the CaS_3O_6 formed meets again with CaS_2, which reduces it to CaS_2O_3 ($CaS_3O_6 + CaS_2 = S + 2\ CaS_2O_3$) the CaS_5O_6. or any other CaS_xO_6, undergoes a similar reduction, and thus the formation of gypsum is almost entirely avoided. Only at the end of an operation there remains a certain small quantity of hyposulphite of lime in the liquors, which is decomposed by adding a quantity of muriatic acid insufficient to saturate the calcium in this hyposulphite, and the clear decomposed liquor, which is run off our precipitating vessels, thus contains, besides chloride of calcium, all the acids mentioned, though in very small quantities.

MONTHLY NOTES.

Jet.—The *Art Journal* for November has an interesting article on jet. It says that the jet manufacture was carried on at Whitby in the time of Queen Elizabeth, but declined soon after. In 1800 it revived, and specimens were then made in the town by the aid of files and knives. The lathe was soon after brought into use, and the manufacture has since increased to an enormous extent; so much so, that it must be regarded as the staple of Whitby. Nearly the whole of the manufactured jet is sent to London and Birmingham and other large towns, to the value of £30,000 annually. Many examples of ornaments in Whitby jet were contributed to the Paris Exhibition. They were of unexceptionable merit in material, but the designs were of a very mediocre character, to say the least; and in consequence the trade has but little advanced by its show in 1867. Yet the best models are at the command of the producers, and there can be no reason why they should not have advanced as the goldsmiths and jewellers generally have done. Jet is not calculated to be worked in all classes of designs, but there can be no difficulty in procuring and copying such as give no suggestion of breaking by the somewhat brittle nature of the material. We hope the manufacturers of Whitby obtained some hints from what they saw in Paris, and that some progress has since been made. There are hundreds of articles that might be made acceptable to persons of refined taste, if the manufacturers would but call artists to their aid. The material has the advantages of being English, very light in wear, much more so than black glass, its usual substitute, and can give employment to artist designers, as well as to skilled artizans. We should gladly aid in promoting its progress by any means in our power.

Progress of the Pacific Railroad.—On the 29th of October the western terminus of the Union Pacific Railroad was at a place called Muddy Creek Bridge, 888 miles west of Omaha, and 177 miles east of Salt Lake. From Muddy Creek Bridge to Salt Lake four-fifths of the track is already graded, and the track is being laid at the rate of two and three miles per day. If no heavy storms intervene, it is expected that the track will be completed and in running order to Salt Lake by the 1st of January, 1869. It has been generally anticipated that the point of meeting of the Union Pacific with the Central Pacific would be at Salt Lake, but according to present appearances the Union Pacific will reach there first, in which ease they will doubtless exercise their right of pushing on the construction of their road westward from that point until they meet the Central Pacific road. The road will run at the north end of Great Salt Lake, thirty-five miles north of Salt Lake City. The 4th of July, 1869, has been for some time past fixed as the date on which the road would be completed, and cars would be run through from Omaha to San Francisco; but the prospects now are that the great work will be accomplished even before that time.—*Exchange.*

An Extraordinary Lamp.—Dr. Richardson has recently constructed a lamp for transmitting light through the structures of the animal body. He believed that the idea that this could be effected was given in Priestley's work on "Electricity." That great chemist had observed, on passing a discharge of a Leyden battery through his finger, that the structure seemed to present luminosity; but the operation was painful. A suggestion of Dr. Mackintosh, last year, had been acted on by Dr. Richardson, who had observed the motion of the heart and of respiration by direct visual means, while these organs were under the influence of various bodies belonging to the ethyl and methyl series. Dr. Richardson had so far extended the principle, that he was enabled to transmit light through various tissues of the bodies of large animals. The particular details of all these interesting and elaborate experiments he described. In a child, the bones could be seen in the arm and wrist. The movements and outline of the heart could also be seen in the chest.

Mount Vesuvius.—The lava thrown out of Mount Vesuvius during the present eruption has been subjected to analysis by an Italian chemist, and found to contain the following ingredients:—Silica, 39 parts; lime, 18; alumina, 14; magnesia, 3; protoxide of iron, 13; potash, 1; soda, 10; water, 2. The specimen, therefore, closely resembled the common glass seen in wine bottles. Lava, though varying considerably in colour and solidity or friability, and occasionally containing little groups of crystalline minerals, would seem to be a sort of rough, natural glass or earthenware, mainly produced from sand, chalk, clay, and similar common earthy substances.

Manufacture of the Extract of Meat.—The *Buenos Ayres Standard*, of 3rd September last, gives the following particulars of the Liebig's Extract of Meat Company's Establishment, at Fray Bentos, on the Uruguay, South America:—"The new factory is a building that covers about 20,000 square feet, and is roofed in iron and glass. We first enter a large flagged hall, kept dark, cool, and extremely clean, where the meat is weighed and passed through apertures to the meat cutting machines. We come to the beef-cutting hall, where are four powerful meat-cutters, specially designed by the company's general manager, Mr. Giebert; each machine can cut the meat of 200 bullocks per hour. The meat, being cut is passed to "digerators" made of wrought iron; each one holds about 12,000 lbs. of beef; there are nine of those digerators, and three more have yet to be put up. Here the meat is digerated by high pressure steam of 75 lbs. per square inch; from this the liquid which contains the extract and the fat of the meat proceeds in tubes to a range of "fat separators," of peculiar construction. Here the fat is separated in the hot state from the extract, as no time can be lost for cool operations, otherwise decomposition would set in in a very short time. We proceed downstairs to an immense hall, sixty feet high, where the fat separators are working; below them is a range of five cast-iron clarifiers, 1000 gallons each, worked by high-pressure steam through Hallett's tube system. Each clarifier is provided with a very ingenious steam tap; in the monstrous clarifiers the albumen and fibrine and phosphate of magnesia are separated. From hence the liquid extract is raised by means of air-pumps, driven by two 30 horse-power engines, up to two vessels about twenty feet above the clarifiers; from thence the liquid runs to the other large evaporators. Now we ascend the staircase reaching the hall, where two immense sets of four vacuum apparatus are at work, evaporating the extract by a very low temperature; here the liquid passes several filtering processes before being evaporated in vacuum. We now ascend some steps and enter the ready making hall, separated by a wire gauze wall, and all windows, doors, &c., guarded by the same to exclude flies and dust. The ventilation is maintained by patent fans, and the place is extremely clean. Here are placed five ready making pans, constructed of steel plates with a system of steel discs, revolving in the liquid extract. These five pans, by medium of discs, 100 in each pan, effect in one minute more than two millions square feet evaporating surface. Here concludes the manufacturing process. The extract is now withdrawn in large cans, and deposited for the following day. Ascending a few steps we enter the decrystallizing and packing hall, where two large cast-iron tanks are placed, provided with hot-water baths under their bottoms; in these tanks the extract is thrown in quantities of 10,000 lbs. at once, and here is decrystallized and made a homogeneous mass, and of uniform quality. Now samples are taken and analyzed by the chemist of the establishment, Dr. Seekamp, under whose charge the chemical and technical operation are performed. It may be mentioned that the company's butcher kills at the rate of 80 oxen per hour; separating by a small double-edged knife the vertebræ, the animal drops down instantaneously on a waggon, and is conducted to a place where 150 men are occupied dressing the meat for the factory, cutting each ox into six pieces; 400 are being worked per day."—*Journal Society of Arts.*

An Artesian Well and Subterranean River.—In sinking the second and last artesian well at the Chicago stock yards, three distinct veins of water were encountered. The first vein was struck in the thick bed of limestone following the second shale, and yielded about 15 barrels an hour. After passing this stream no water was seen until the 90 feet of limestone under the first sandstone had been reached. In this rock a very extensive spring, flowing at the surface of the well about 65,000 gallons a day, was opened. The third and large vein was struck in a bed of hard limestone, 1190 feet from the starlight. The following table will show the depth from the surface at which the several strata commence, and the beds in which streams of water were found. Water was not found at the depths indicated, but was in the rocks which commenced at those depths:—

Distance from surface.	Nature of rock.
Beneath surface of earth.	Hardpan.
40 feet,	First limestone.
300 feet,	First shale.
400 feet,	Second limestone.
420 feet,	Second shale.
550 feet (first water),	Third limestone.
877 feet,	First sandstone.
1,010 feet (second water),	Third limestone.
1,100 feet,	Last limestone.
1,130 feet,	Sand and limestone.
1,160 feet,	Same, but harder.
1,172 feet,	Last limestone.
1,190 feet (third water),	Same.

The vein from which the greatest supply of water was obtained appears to be about eight feet in depth, so far as can be ascertained by sounding. The current is a very strong one, and is apparently passing from the north-west to the south-east. This fact was ascertained by lowering into the bore, by means of a fine wire, a long lead plummet. The weight would descend steadily until it reached the stream of water, when it would instantaneously be snatched or jerked out from the perpendicular line from the direction indicated. In relation to the velocity of the stream, one of the attendants explained that it was "about the swiftness of a cat-fish." The experiment with the plummet explains this remark. The current of water is sufficiently strong and rapid to snatch the heavy lead, and bear it away, as a fish would snatch an insect, and carry it beneath the surface of the river. The water in the wells presents a marked and singular difference. In the old well it is strongly impregnated with sulphur. So thorough is the impregnation, that the water not only smells and tastes of the substance, but deposits it profusely at the bottom of the trough in which it is received, and the tank in which it is collected. After exposure to the air for a few hours, the sulphur is precipitated and partly carried off by the air, leaving a perfectly colourless and tasteless fluid. In the second well, on the other hand, there are no sulphurous evidences; but the water is strongly charged with one of the oxides of iron. It has no perceptible odour, but chalybeate characteristics are very apparent to the taste; and to the eye, in the iron-brown deposit which covers the bottom of the receiving trough. The force of the water of the last well is sufficient to discharge 600,000 gallons a day at the surface. In carrying itself to the height of the tanks, an altitude of 45 feet from the ground, it loses so much force that only 450,000 gallons are discharged at this point daily. It is estimated that at a further height of 130 feet, being 175 from the surface, the water would assume a stationary position, and would readily obey King Canute or "any other man," if he told it to rise no farther. The wells are both now in running operation at the stock yards. They are the only means used in the supply of the immense amount of water there constantly required, and prove highly successful in every respect.—*Chicago Times.*

Supply of Iced Water to Paris.—Every one who has visited the cafés of Paris, must have observed the *carafes frappées*, that is to say, water bottles with a great block of ice, often very curiously crystallized inside. The production of these frozen decanters has become a very important operation, which is carried on at ice houses situated in the Boulevard Launes, on the Passy side of the Bois de Boulogne. The establishment consists of ten great underground ice vaults, protected from the action of the sun by buildings raised over them, and covered with straw. Each of the ice vaults is nearly 500 feet long, and about 36 feet high, and the ten are capable of holding ten thousand tons of ice. The department in which the water bottles is frozen is a curiosity. These decanters are two-thirds filled with filtered water in the receptacles of the freezing machine, and the freezing is produced by means of salt water and vaporized ether. A steam engine of sixteen horse-power is employed to work two air-pumps, which produce the vacuum in the copper reservoirs, placed in the salt-water basins. After a short time the water within the decanters is reduced below freezing point, and yet it is not frozen. Each bottle is then taken in hand by a workman and its contents rapidly stirred with a stick, and the freezing takes place as if by magic. More than six thousand of these frozen carafes are sent out daily in hot weather at a very trifling charge, and each being filled up with fresh water as often as required, will serve during a long summer day and cool ten gallons of water, so that the Parisians are supplied by this establishment with about sixty thousand gallons of iced water per day. The economy of this system, as compared with the use of pure broken ice, half of which is wasted, is very evident; and besides, the ice in the frozen carafes is produced from pure filtered water. Why should not London and other large towns have their frozen water bottles as well as Paris? It would almost certainly *pay* in London for four months of our year.

Joublin's Apparatus for Cleaning Boiler Tubes.[*]—M. V. J. Joublin, engineer of the imperial marine, Toulon, has recently devised a peculiar arrangement of apparatus for cleaning boiler tubes, which obviates the necessity for taking them to pieces. It consists of scraper-chains, the links of which are provided with teeth, which scrape and clean off the deposits from the surface of the tubes, under the action of a to and fro motion which is imparted to the chain after placing it round the tubes. The direction of the chains may be either rectilineal, or helicoidal, according to the nature of the work to be done, but their combination is the same in both cases. That of the rectilineal direction is more especially intended to clean the tubes at their end, near the boiler plates, whilst the other is designed for the cleaning of the tube throughout its length. The maximum height of the links, which may be crossed from the ends to towards the middle, is equal to the interval between two consecutive tubes in the vertical direction (a little clearance being allowed), so that the chain will operate equally well on the lower tube as on that the lower half of which it is intended to clean. A ring is formed on each end of the chain, through which a leather strap or cord is passed, which serves to manœuvre it. In order to use the chain, a line or cord is attached to one of the leather straps, and is let down between two rows of tubes, and the operator lays hold of the other extremity of the cord with a bent hook, and draws it towards him. By thus drawing up one end of the cord and paying out the other, the chain is brought under the tube which it is required to clean, and the scraping is effected by imparting to the chain a to and fro motion combined with a sliding motion, proportionate to the quantity of deposit detached from the tube. The chain may be passed over several tubes at the same time, in order that the operation of cleaning may be performed on several simultaneously.

Proposed Central Asiatic Railway.—The *New York Tribune* states that the emperor of Russia has sent two civil engineers to the United States, who are to examine the operations of the Pacific and other great railways in that country. "The emperor," the *Tribune* adds, "contemplates building a railroad from China, across Asia, to the capital of Russia, his purpose being to prevent the United States, with its railroads and steamships, from monopolizing the whole China trade.

APPLICATIONS FOR
PROVISIONAL PROTECTION FOR INVENTIONS
UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

5th December, 1868.

3700 E. Francillon, Paris—Dyeing fur and hair
3701 J. A. Fawcett, Wakefield—Supplying steam-boilers with fuel
3702 B. Hunt, Lincoln's Inn—Railway carriage wheels.—A com.
3703 D. Thomson, Johnstone—Sawing machinery
3704 R. Girdwood, Edinburgh—Reducing ores
3705 H. Denton, Wolverhampton—Chain harrows
3706 E. K. Dutton, Manchester—Gig mills.—A com.
3707 A. V. Newton, Chancery Lane—Treating flour.—A com.
3708 A. Masson, Edinburgh—Steam-engines
3709 J. Abraham, Birmingham—Central-fire cartridges
3710 J. Holmes, Bradford—Kilns
3711 B. Fowler, D. Greig, and R. Burton, Leeds—Steam cultivating machinery
3712 D. H. Paterson, Sprucefield—Bleaching textile materials
3713 W. R. Lake, Chancery Lane—Printer's type.—A com.
3714 A. M. Clark, Chancery Lane—Treating sewage.—A com.

7th December, 1868.

3715 A. B. Berard, Paris—Purifying gas
3716 J. E. Woolf, New Bond Street—Cooling milk.—A com.
3717 W. Chiswell, Islington—Preventing horses slipping
3718 A. Homfray, Halesowen—Manufacturing coke
3719 J. Ridley, Belsize Park—Obtaining motive power
3720 A. Krupp, Essen—Breech-loading ordnance
3721 E. Simons, Sheffield—Horse shoes
3722 W. R. Lake, Chancery Lane—Photographing by artificial light.—A com.
3723 W. R. Lake, Chancery Lane—Railway carriage wheels.—A com.
3724 C. F. C. Cretin, and J. Watson, Glasgow—Supplying air to divers
3725 T. Kennan, Dublin—Fences
3726 A. M. Clark, Chancery Lane—Thread winders.—A com.

8th December, 1868.

3727 C. Farrar, Bow—Reducing wood to fibres
3728 A. Mackie, Warrington—Type composing machinery
3729 H. A. Bonneville, Piccadilly—Spinning looms.—A com.
3730 W. J. Thicthener, Islington—Chronometer watches
3731 J. A. Farwig, South Norwood, and C. Haynes, Bermondsey New Road—Sheet metal casks
3732 J. Fitter, Birmingham—Manufacturing nuts
3733 O. Reynolds, Manchester—Communicating in railway trains
3734 R. B. Roden, Usk—Breech-loading fire-arms
3735 T. Speir, Blackstone—Land cultivating machinery
3736 T. Speir, Blackstone—Land cultivating machinery
3737 T. Lancaster, Liverpool—Economizing fuel
3738 F. W. & G. Moss, Leicester—Preventing railway collisions
3739 G. Cooper, Deptford, and J. Cotterill, Shoreditch—Crucibles
3740 C. P. Cotton and J. L. Lyster, Dublin—Limestone kilns
3741 W. H. Pottle, Gray's Inn Road—Umbrellas
3742 J. & J. Kirk, New Lenton—Manufacturing weavings
3743 J. Ball, Nottingham—Lace
3744 G. P. White, Furnival's Inn—Bridge roadways
3745 W. Baines, Smethwick—Working railway switches

9th December, 1868.

3746 S. S. Anderson, Bishop Auckland—Bricks
3747 J. T. Parlour, Chancery Lane—Adjustable blocks
3748 F. Meadows, Red Lion Court—Cutting strips of metal
3749 R. Needham, Dukinfield—Fuel economizers
3750 J. Bolton, Bristol—Burning animal charcoal
3751 J. Parkins, Golden Square—Stamping machinery
3752 F. Sturgeon, Manchester—Communicating in trains
3753 A. G. Goodes, Newgate Street—Cigars and cheroots

10th December, 1868.

3754 W. Griffiths, Grosvenor Square—Bridles
3755 J. Norman, Glasgow—Grain-grinding apparatus
3756 W. H. Platt, Ashton under Lyne—Shuttles
3757 W. G. Manwaring, Banbury—Sewing machines
3758 A. Matthiesen, St. Bartholomew's Hospital—Paper
3759 H. A. Bonneville, Piccadilly—Measuring apparatus.—A com.
3760 W. Gray and T. Biggin, Sheffield—Spanners
3761 W. S. Jackson, Walworth—Treating bones
3762 J. Smith, Kingsland, and J. F. N. B. Simons, Great St. Helens—Steam-boilers.—A com
3763 C. E. Brooman, Fleet Street—Roofing houses.—A com.
3764 J. F. Bentley, Peterborough—Wells
3765 W. Dawes and E. A. Ramsden, Leeds—Musical instruments

11th December, 1868

3766 J. Pickles, E. Ramsbotton, S. Haggas, S. Foulds, J. Shackleton, Bingley, and W. Berry, Bradford—Spinning frames
3767 R. Waygood, Newington—Ventilating mines
3768 T. Holder, Barnsbury, and G. Dover, Holloway—Horse shoes
3769 H. Carter and G. H. Edwards, Bow—Breech-loading fire-arms
3770 P. Kotzo, Strand—Reaping machines
3771 W. H. Bailey, Salford—Indicating heat
3772 F. Walton, Staines—Constructing houses

12th December, 1868.

3773 E. H. Bayley, Southwark—Filter vans
3774 B. Hunt, Lincoln's Inn—Cooking apparatus.—A com.
3775 J. Millward, Birmingham—Preserving meat.—A com.
3776 A. Woods, Holloway—Spring mattresses
3777 H. Law, Strand—Water-closets
3778 C. Ellison and E. Parkinson, Leeds—Measuring apparatus
3779 T. Smith, Birmingham—Smith's bellows
3780 Z. Poirier, South Lambeth—Safety stopper for bottles
3781 S. Cowperthwaite, Leeds—Turning materials
3782 C. E. Brooman, Fleet Street—Indicating hours.—A com.
3783 G. Preston and J. Prestige, Deptford—Engine lubricators
3784 F. Erskine, Manchester—Economizing fuel
3785 J. Hamilton and J. B. Crawford, Glasgow—Tools for cutting stone
3786 A. Prince, Charing Cross—Treating ores.—A com.
3787 G. A. C. Bremme, Liverpool—Softening flax
3788 H. L. D. Marsden, Louth—Framings for bridges
3789 J. Hine, Cockermouth—Cutting millstones

14th December, 1868.

3790 R. Norfolk, Beverley—Reaping machines
3791 W. Meakin, Marylebone—Adjustable lock spindles
3792 H. E. Newton, Chancery Lane—Transmitting motive power
3793 J. J. Stevens, Southwark—Railway switches
3794 S. W. Smith, Leeds—Spinning fibrous materials
3795 J. Allmark, Oldham, and W. Blakey, Liverpool—Tobacco-cutting machine
3796 C. E. Brooman, Fleet Street—Door locks.—A com.
3797 W. J. Murphy, Cork—Ordnance
3798 J. Thonas, Kennington Lane—Tea kettles
3799 J. Hay, Piccadilly—Engine counters
3800 T. Lynch, Ennishowen—Preventing collisions on railways

15th December, 1868.

3801 A. Watt, Gracechurch Street—Metallic rollers
3802 J. H. Brown, Romsey—Helmets
3803 C. Mather, Salford—Cleaning cotton.—A com.
3804 H. A. Bonneville, Piccadilly—Motive power.—A com.
3805 H. Williamson, Denton—Felt hats
3806 A. Baumann, Cecil Street—Slide valves
3807 R. S. Garden, Piccadilly—Portable cartridge box
3808 W. Bywater, Leeds—Felt
3809 J. W. Chilcot, Portsea—Stays
3810 C. A. B. Pocock, South Shields—Railway carriage bedsteads
3811 C. E. Brooman, Fleet Street—Diving apparatus.—A com.
3812 M. Lockhart, Douglas—Ventilating chimneys
3813 M. B. Westhead and R. Smith, Manchester—Spools
3814 J. Frazer and W. Naar, Bayswater—Mattresses
3815 P. Kotzo, Strand—Steam-engines
3816 T. Wilson, Birmingham—Railway couplings
3817 J. T. Grice, Birmingham—Ornamenting metallic tubes
3818 J. E. Scriven, Mulhuddart—Turkish baths

16th December, 1868.

3819 J. Mill, Southampton—Heating press plates
3820 W. Cotton, Loughborough, and E. Attenborough, Nottingham—Looped fabrics.
3821 W. N. Nicholson, Newark-upon-Trent—Portable mangle
3822 W. A. Verel and J. Cameron, Glasgow—Extracting copper from slag
3823 O. Hollingworth, Westbourne Park—Combined open and closed carriage
3824 J. B. Everard, Leicester—Rock drilling machines
3825 T. C. Fioler, Ventnor—Railway rolling stock
3826 L. Desens, Charing Cross—Miners' lamps

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[*] Translated from *La Propagation Industrielle.*

3827 R. Wappenstein and R. Ray, Manchester—Registering apparatus for omnibuses
3823 A. M. Clark, Chancery Lane—Inlaying metals.—A com.
3829 J. Worrall, Manchester, and J. Kershaw, Halifax—Drying stoves
3830 T. Aveling, Rochester—Steam cultivation
3831 F. Ryland, West Bromwich—Saucepan lids
3832 S. C. Lister, Bradford—Steam boilers
3833 G. Ritchie, Folkestone—Compositions for woven fabrics
3834 S. C. Lister, Bradford—Preparing wool

17*th December*, 1868.

3835 J. T. Hall and G. Critchley, Liverpool, and H. B. Fox, Oxton—Self-acting rack
3836 J. Thorniley and G. B. Wing—Restoring worn-out files
3837 G. Hadfield, Lancaster—Varnish
3838 F. R. Theurer, Switzerland—Watches
3839 A. Perry, Dartford—Illuminating painted windows
3840 W. H. Lennox, Hampstead Road, and W. J. Pearman, Oxford Street—Printing surfaces
3841 W. Manners, Nottingham—Railway danger signals
3812 G. H. Benson, Staleybridge, and W. G. Valentine, Royal College of Chemistry—Iron and steel
3843 G. H. Benson, Staleybridge, and W. G. Valentine, Royal College of Chemistry—Producing combustible gases
3844 T. Inglis and T. English, Her Majesty's War Office—Tubes or cylinders
3845 F. H. Knevitt, Cornhill, and H. H. Hazard, Cheapside—Window blinds
3846 J. C. Walker, Hackney Wick—Acid powder
3847 R. Hallimond, Bishop Auckland—Lubricators
3848 J. Quick, Southwark, and J. Sampson, Battersea Park—Pistons
3849 J. Pouncy, Dorchester—Plain photographic pictures

18*th December*, 1368.

3850 C. Liebermann and C. Graeble, Berlin—Colouring matters
3851 E. T. Hughes, Chancery Lane—Floating vessels.—A com.
3852 E. T. Hughes, Chancery Lane—Tea urns.—A com.
3853 J. W. Brierley, Oldham—Forging nuts
3854 W. F. Thomas, Cheapside—Sewing machines
3855 J. Hodgson, H. Bottomley, and E. Cockroft, Bradford—Weaving
3856 E. S. Griffiths, Sheerness—Anchors
3857 T. B. Salter and J. Silvester, West Bromwich—Steam gauges
3858 J. Edridge and J. Merrett, Birmingham—Tinning pins
3859 S. Remington, Chancery Lane—Breech-loading fire-arms
3860 D. Imhof, Oxford Street—Organ chimes
3861 T. Spencer, Bolton-le-Moors—Spinning cotton
3862 G. D. Robinson, King's Cross—Carriages
3863 E. P. H. Vaughan, Chancery Lane—Rosin oil.—A com.
3864 E. Pavy, Paris, and J. Clark, Manchester—Treating jute
3865 J. Petrie, Rochdale, and W. T. Cheetham, Ashton-under-Lyne—Warming apparatus
3866 M. B. Westhead and R. Smith, Manchester—Thread

19*th December*, 1868.

3867 L. E. Leroy, Paris—System of publicity
3868 J. Brierley, Blackburn—Ventilating sewers
3869 M. S. Maynard and R. Grime, Preston—Motive-power engines
3870 R. Spence, Manchester—Manufacturing alum
3871 J. Jones, Wolverhampton—Drawing vapour from baths
3872 W. S. Thomson, Cheapside—Ladies' skirts.—Partly a com.
3873 J. Dickson, Leith—Constructing windows
3874 G. H. Asker, Norwich—Umbrellas
3875 T. Warwick and A. Boyle, Birmingham—Umbrella ribs

21*st December*, 1868.

3876 W. R. Lake, Chancery Lane—Cutting rocks.—A com.
3877 T. R. Shaw, Pendleton—Lubricating bearings of shafts
3878 W. F. Stanley, Holborn—Electric machines
3879 R. Wilson, Manchester—Metal cutting tools
3880 J. E. Massey, Clerkenwell—Sounding machines
3881 H. G. Thompson, Chancery Lane—Carpets
3882 W. Lewis, Shrewsbury—Ploughs
3883 J. Baggs, High Holborn—Manufacturing iron
3884 J. S. Walker, Wigan—Undermining coal
3885 L. A. W. Lund and E. Axmann, London—Brooches
3886 E. A. Cowper, Westminster—Velocipedes
3887 R. Whitaker, Wolverhampton—Locks
3888 W. Pidding, Walcot Square—Locomotion
3889 J. Wilkinson, Leeds—Saddle cloths
3890 T. B. Hubbell, Euston Square—Female bandages.—A com.
3891 J. H. Johnson, Lincoln's Inn Fields—Sharpening saws
3392 H. W. Hammond, Manchester—Spring pail washer.—A com.
3893 W. E. Gedge, Strand—Resinous bitumen.—A com.
3894 P. G. Garre, Paris—Hydropneumatic pump
3895 W. E. Gedge, Strand—Cocks.—A com.
3896 J. Breeden, Birmingham—Taps or valves
3897 J. C. Cayton, Preston—Steam valves
3898 G. Ritchie, Folkestone—Parasols
3899 W. R. Clark, Foresthill—Communicating in railway trains
3900 H. T. Vanner and E. Prest, Great St. Helens—Currying leather.—A com.

22*nd December*, 1868.

3901 L. J. Paine, Oxford Street—Removable collars and comforters combined
3902 C. J. Jensen, Norway—Reefing ships' sails
3903 W. Challiner, Sheffield—Steel forks
3904 J. Palmer, Sutton Coldfield—Agricultural steel forks
3905 G. Tidcombe, Watford—Paper-making machinery
3906 J. H. Johnson, Lincoln's Inn Fields—Pulleys.—A com.
3907 F. N. Gisborne, West Strand—Torpedoes
3908 S. Smart, Bromley—Steam boilers
3909 F. N. Gisborne, West Strand—Generating gas
3910 J. Snape, Aberdare—Pumps
3911 D. S. Price, Westminster—Iron and steel
3912 A. Sezille, Paris—Treating corn
3913 W. Clay, Liverpool—Forgings
3914 J. G. Jennings, Lambeth—Treating sewage
3915 B. Norton, Huddersfield—Tipping pile fabrics
3916 W. E. Gedge, Strand—Floating docks.—A com.

23*rd December*, 1363.

3917 B. W. Maughan, Goswell Road—Heating water
3913 E. M. Thornton, Holborn—Footstools
3919 G. M. Wolmershausen, Mayfair—Obtaining the form of the human figure
3920 W. G. Reeve, Greenwich—Inkstands
3921 G. Hookham, Oxford—Sash linens
3922 G. Lowry, Salford—Bushes for casks
3923 H. G. Thompson, Chancery Lane—Cut pile fabrics
3924 J. H. Johnson, Lincoln's Inn Fields—Artificial teeth.—A com.
3925 W. E. Gedge, Strand—Electric bell-sounding apparatus.—A com.
3926 F. P. Warren, Lee—Cooking apparatus
3927 J. W. Wilson, Strand—Hydraulic lifts
3928 A. V. Newton, Chancery Lane—Treating cod liver oil.—A com.
3929 A. M. Clark, Chancery Lane—Gas burners.—A com.

24*th December*, 1868.

3930 W. H. Walenn, Islington—Copper and brass
3931 T. Warren, Glasgow—Glass furnaces
3932 J. H. Johnson, Lincoln's Inn Fields—Telegraphic despatches.—A com.
3933 W. R. Lake, Chancery Lane—Carriage boat.—A com.
3934 C. D. Abel, Chancery Lane—Rolling mills.—A com.
3935 H. Robinson, Lewisham, and J. Smith, Carshalton—Dressing millstones
3 36 R. Roby, Bury St. Edmunds—Malt kilns
3937 H. C. M. Turnbull, Piccadilly—Working fans
3838 H. Clifford, Greenwich—Submarine telegraph cables
3939 W. H. Ridgway and F. W. Walker, Hanley—Ornamental bricks
3940 A. C. Pilliner and J. C. Hill, Newport—Obtaining motive power
3941 G. T. Bousfield, Brixton—Steam valves.—A com.
3942 W. Ehrhardt, Birmingham—Watches
3943 H. Hillebrandt, Birmingham—Repeating fire arms.—A com.

26*th December*, 1868.

3944 C. E. Brooman, Fleet Street—Portable lamp.—A com.
3945 E. Butterworth, Rochdale—Furnaces
3946 C. Gordon, Goswell Road—Breech-loading fire-arms
3947 G. Eldridge, Dalston, and J. Smith, Islington—Closing casks

28*th December*, 1863.

3948 J. P. Mills, Wilmington Square—Pianoforte keys
3949 A. S. Harington, Piccadilly—Tobacco pouch
3950 W. R. Lake, Chancery Lane—Pegging boots.—A com.
3951 H. Yorath, Cowbridge—Hay stacks

29*th December*, 1868.

3952 C. D. Abel, Chancery Lane—Wrought metal pipes.—A com.
3953 J. A. A. Landa, Paris—Engraving letters
3954 A. Browne, King William Street—Illuminating gas.—A com.
3955 J. Pick, Falcon Square—Hand bags
3956 F. A. V. Michel, Paris—Printing surfaces
3957 J. Gillman, Wolverhampton—Lever scale
3958 F. N. Gisborne, West Strand—Sewing machines
3959 G. T. Bousfield, Brixton—Extracting colour from madder root.—A com.
3960 G. Slater, Lambs Passage—Doubling cloth
3961 J. Marsh, Westminster—Capping bottles

30*th December*, 1868.

3962 R. & T. Hughes, New Cross—Velocipedes
3963 J. Laurie and J. Whittaker, Seacombe Rivet and Bolt Works—Screwing machinery
3964 S. & W. Fox and J. Reffitt, Leeds, and G. Grange, Pateley Bridge—Cutting apparatus
3965 A. G. Gazalat, Paris—Steel
3966 J. & A. Hutcheson, Glasgow—Elevator
3967 T. T. Henley, Pimlico—Producing shellac
3968 J. H. Johnson, Lincoln's Inn Fields—Paper tubes.—A com.
3969 W. Winter, Leeds—Sewing machines
3970 C. Monestier and J. Bang, Paris—Impermeable paper
3971 G. Davies, Manchester—Separating ores.—A com.
3972 P. & R. Gornall, Blackburn—Manufacturing cotton
3973 H. H. Bigg, Cavendish Square—Artificial legs
3974 E. T. Noualhier, Paris—Air-exhausting apparatus
3975 J. Gedge, Margate—Gas apparatus

31*st December*, 1868.

3976 H. A. Bonneville, Piccadilly—Drying malt.—A com.
3977 C. De Bergue, Strand—Railways
3978 W. E. Gedge, Strand—Sweetmeat.—A com.
3979 W. R. Lake, Chancery Lane—Spinning machine.—A com.
3981 F. A. K. W. von Oppen, Pall Mall—Breech-loading fire arms
3982 A. Barclay, Kilmarnock.—Air pumps
3983 B. Samuelson, Banbury—Iron and steel
3984 D. Spill, Hackney—Producing compounds containing xyloidine
3985 G. M. Wells, Barnsbury—Wrenches.—A com.
3986 H. E. Newton, Chancery Lane—Washing machines.—A com.
3987 W. E. Newton, Chancery Lane—Revolving fire arms.—A com.
3988 R. Griffiths, Mold—Propelling vessels
3989 T. Gibson, Newcastle-on-Tyne—Railway buffers
3990 J. Seelig, Bunhill Row—Ventilating hats
3991 C. Shales, Westbourne Grove—Tatting shuttles

1*st January*, 1869.

1 J. Heap, Ashton-under-Lyne—Lathes
2 T. Singleton, Over Darwen—Preparing yarn
3 S. Lyons, Finsbury—Producing designs on textile fabrics
4 W. M. Williams, Sheffield—Puddling furnaces
5 G. Smith, Strand—Horse-clipping machinery
6 T. Green, Leeds—Steam-boilers
7 T. Green, W. Burrows, and R. Turner, Leeds—Bungholes of casks
8 B. G. George, Hatton Garden—Show cards
9 F. Perry, Fenchurch Street—Preserving vegetable substances.—A com.
10 M. Henry, Fleet Street—Combing fibrous materials.—A com.

2*nd January*, 1869.

11 J. H. Johnson, Lincoln's Inn Fields—Velocipedes.—A com.
12 S. Smithson, Heckmondwike, G. Senior, and J. Inman, Brighouse—Taps and valves
13 A. Batchelar, Brockham—Brick kilns
14 W. G. Rawbone, Birmingham—Breech-loading fire-arms
15 A. Carter, Birmingham, and C. R. E. Grubb, Dalston—Candlesticks
16 J. G. Tongue, Chancery Lane—Sewing volumes.—A com.

4*th January*, 1869.

17 M. Wolfsky, Ludgate Hill—Purse locks
13 H. A. Bonneville, Piccadilly—Refining iron.—A com.
19 W. A. Biddell and J. Redgrave, Birmingham—Chandeliers
20 S. J. Peet, Leeds—Valves or cocks
21 J. M'Kenny, Dublin—Horse shoes
22 J. Mayor, H. Trigg, and W. Wright, Swallow Street—White lead

5*th January*, 1869.

23 H. A. Bonneville, Piccadilly—Coating articles with gold.—A com.
24 L. Hannart, Clerkenwell—Printers' type
25 S. Bateman, Paris—Paddle wheels
26 W. Prosser, Lancaster—Purifying oils
27 E. W. & J. Voce, Salford—Rotary fans
28 E. Fox, Sheffield—Iron and steel
29 J. G. Hays, King's Cross—Drying peat
30 J. Balbirnie, Sheffield—Apparatus for inhaling vapours
31 J. H. Johnson, Lincoln's Inn Fields—Sewing machines.—A com.
32 A. Mason, Strand—Hydrocarbon oils.—A com.
33 G. Smith, Manchester—Smoke furnaces
34 D. Nicoll, Cornhill—Male and female clothing
35 W. Dawes, Leeds—Steam-engines
36 S. Remington, Chancery Lane—Breech-loading fire-arms
37 A. W. E. Williams, Connecticut—Lawn mowers.—A com.
38 J. Stevens, Chancery Lane—Linen plaiting machine

Fig. 5.

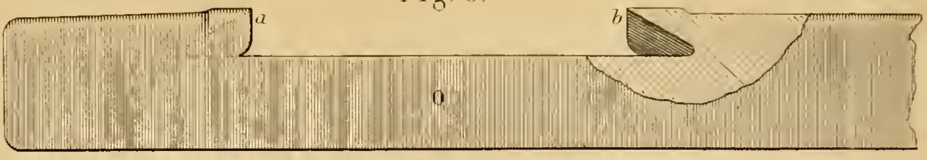


Fig. 6.

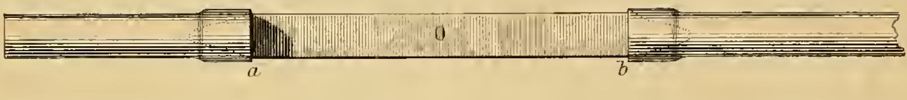


Fig. 1.

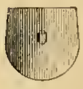
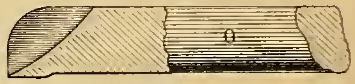


Fig. 2.



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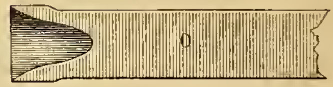
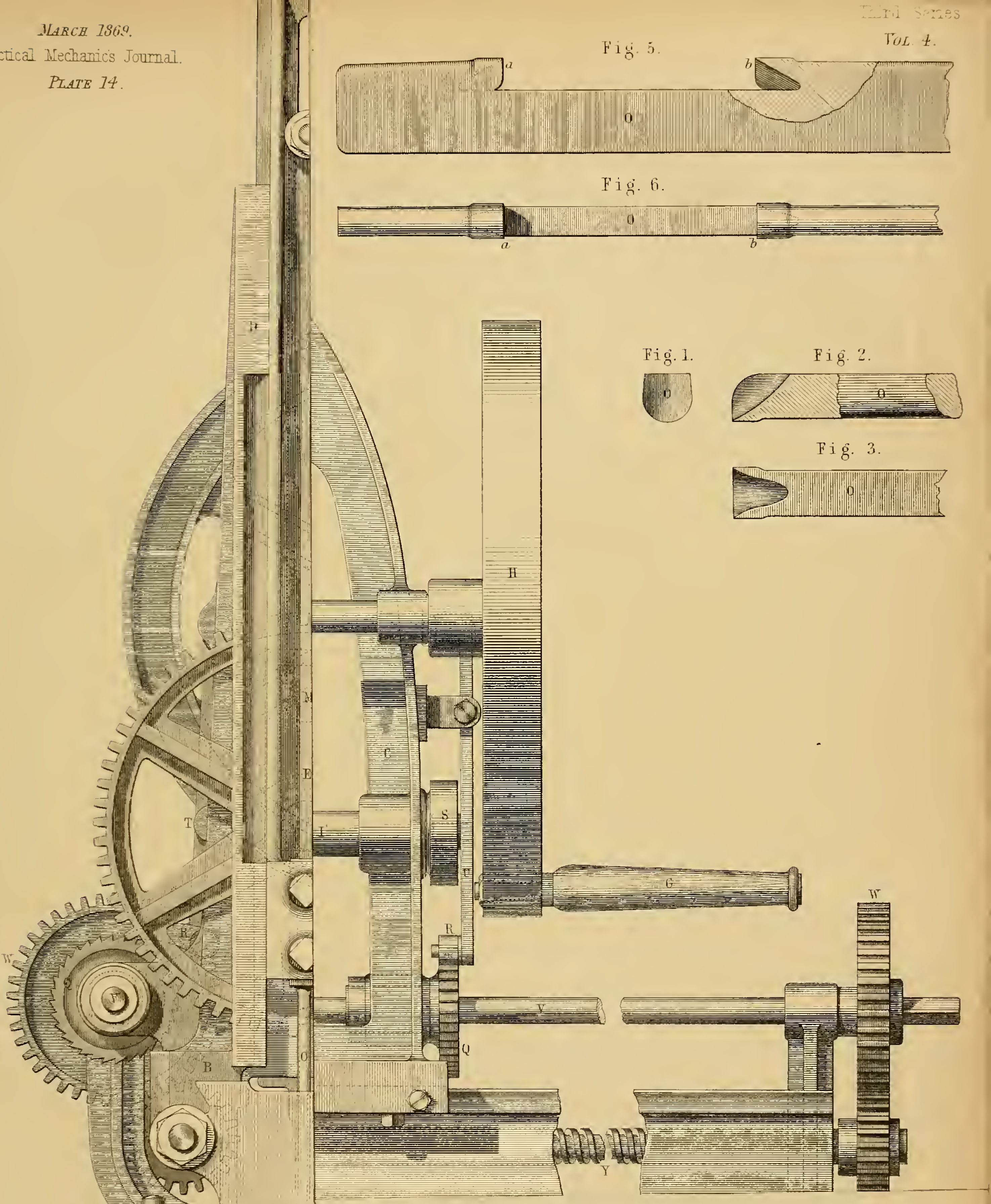




March 1869.
Practical Mechanics Journal
Plate 14.

ROCK CUTTING TOOLS AND MACHINERY.

J. D. BRUNTON. C. E.
Patentee.

Third Series
Vol. 4.

Fig. 7.

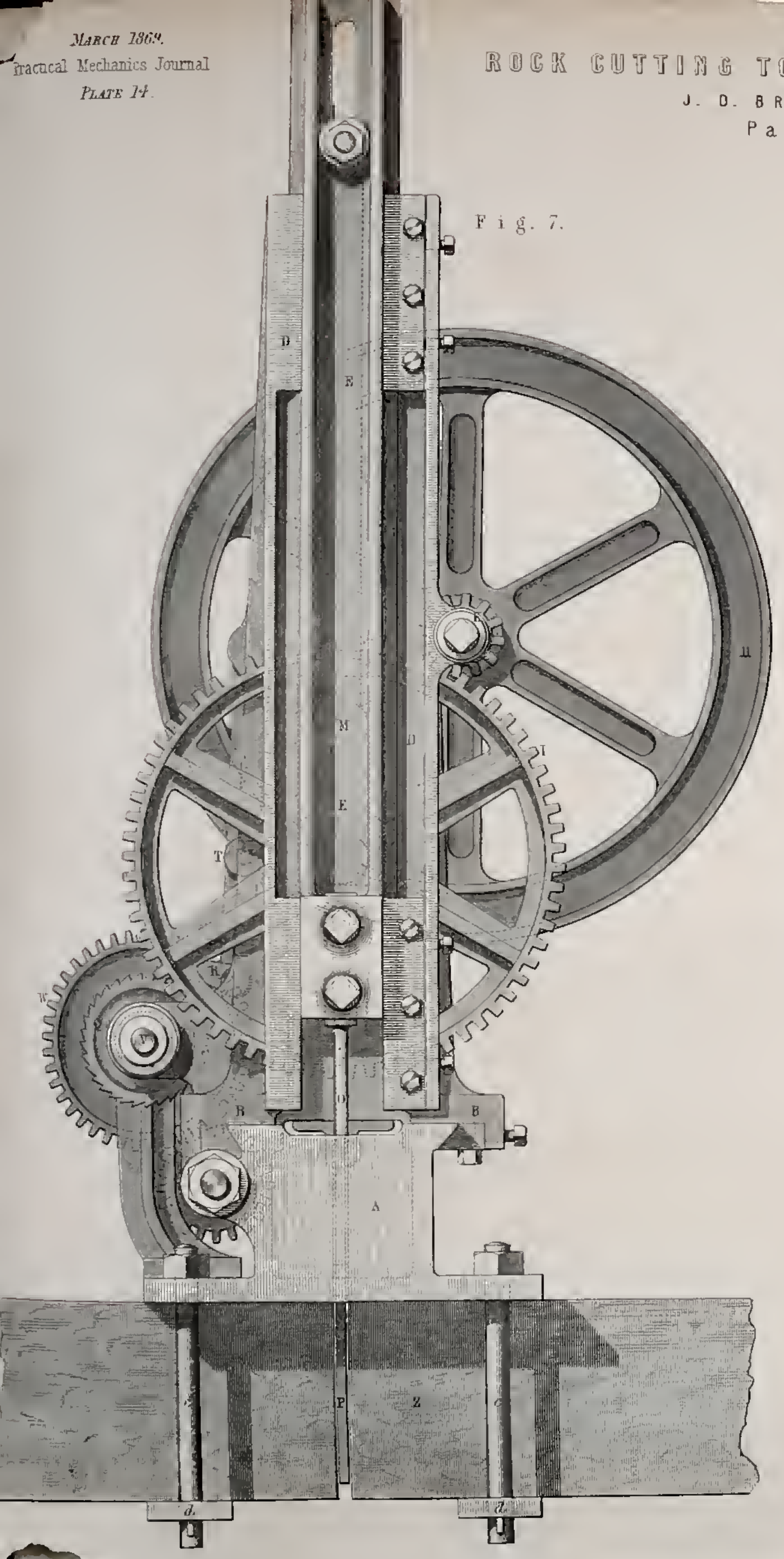
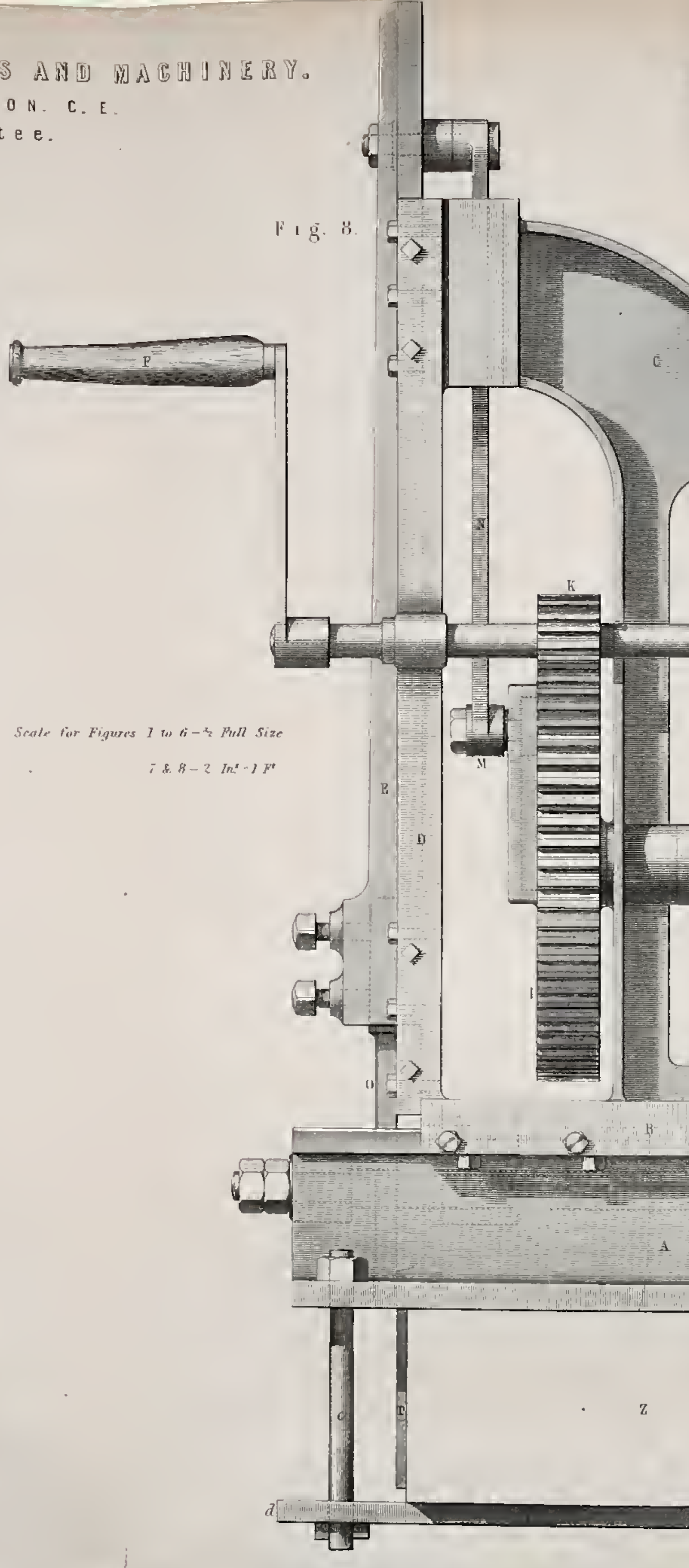
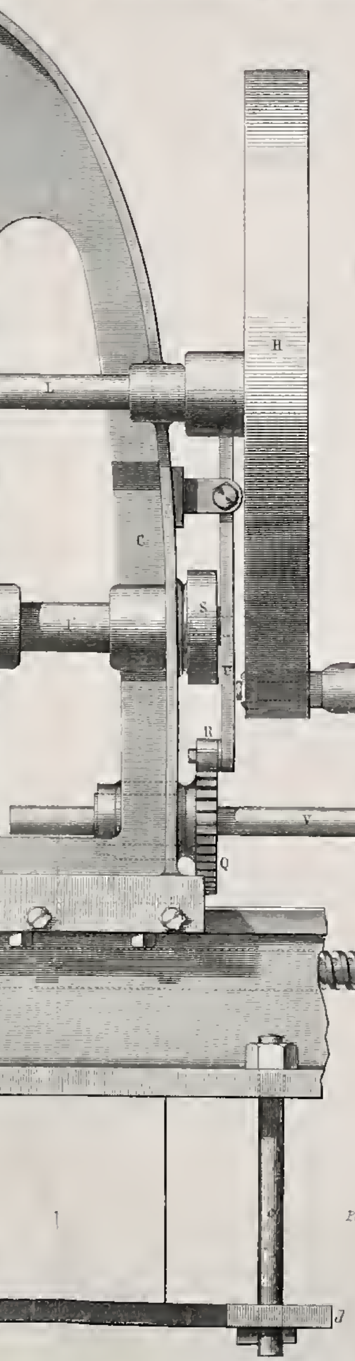


Fig. 8.





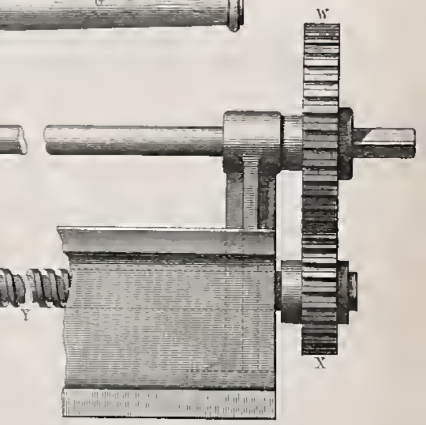


Fig. 4.

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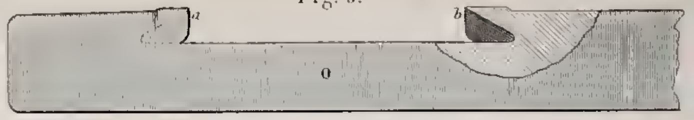

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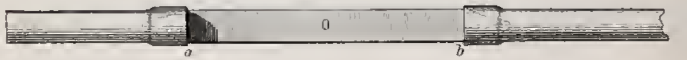

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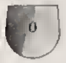

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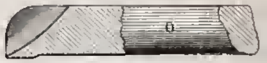

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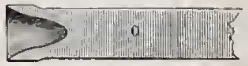

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REMARKS UPON SOME RECENT IMPROVEMENTS AND PROJECTS FOR IMPROVEMENT IN COAL GETTING.

THAT which has more than anything else characterized the mechanical progress of our own times, the steady and increasing substitution of machine agency for human and animal labour, has not until within a very few years made much advance in the underground workings of the coal-pit. Some grand ameliorations have been made, which now date happily from a good many years back; women and children are no longer as a rule, if at all, worked as beasts of burden—in darkness, moral and material, that made their lot such, that too often dense ignorance alone in mercy cloaked from them the fact, that it had been better they had never been born.

The humanizing effects of long-continued peace acting on the minds of many, public opinion, and the law, made this change, rather than the willing skill of the coal owner or the colliery engineer. There is plenty of room still, however, for improvement in this direction; trap boys and rolley boys, and so forth, are a good way removed from even the lot of the probably ill-fed and worse-lodged ploughboy, who at least rises to inhale the balmy sweetness of the morning air, and whistles as he listens to the lark above his head, soaring into the blue heaven to greet the rising sun.

The poor lot of the thin-seam hewer of midland counties' coal of older days—who grew warped and crippled by labouring for his life-long, lying upon his side, between two surfaces but a few inches apart, five hundred feet of rocky roof imminent above him, half-embedded in small coal, and half-choked with the dust of his own blows—has been greatly holpen, partly because the working of those excessively thin seams has been to a large extent abandoned, since the heavy beds of the north and the south have gotten into fuller and fuller swing, and since emigration and gold discoveries have raised the price of wages. But much remains to be done; and so surely as the sewing machine was the true remedy for the miseries (not yet gone, however) shadowed in the "Song of the Shirt," so must the effectual removal of the remaining ills of coal-pit labour (and of all other labour of analogous character) be found not so much in legislation as in the invention of effective methods for superseding it.

There have been other sufferings in coal-pit labour besides human ones. Horses, or "ponies," as they are called in coal-pits, whatever may be their size, have been, and are still, largely employed in drawing the "corves" of coal from the headings to the bottom of the "drawing shaft." Without being sentimental, it may be boldly said that few animal existences can be more unnatural or unhappy than that of the coal-pit horse; gathered into an animated lump, tied limb to limb, lowered into darkness and impure air, and from that moment condemned to spend the rest of his days without sun or stars, nor any one enjoyment of his animal existence but that derived from the daily meal that rewards his daily toil, until death releases him, and sends his carcase once more to day, or consigns it to some remote corner of a "waste," never more to be seen, unless some palæontologist of a million years hence should disinter his fossilized bones. But the increased depth of workings, the extension of underground "inclines," and many other circumstances, all converging towards the question of "cost," have sharpened the wits of coal viewers and engineers; and already vast progress has been made in the north of England and elsewhere, in substituting steam-power haulage underground, by means of the "endless rope system," for horse labour. Thus not universally, but within certain limits, we see the curious succession, of women and girls as beasts of burden giving way to boys and men, these to "ponies," and the last to steam. Several years have elapsed since the earliest attempts were made in Northumberland and Durham to apply mechanical haulage, by one of the four systems under which it is at present worked, viz., by that of the single tail rope; and at least five years ago we ourselves witnessed in the Hetton collieries the degree of perfection to which that plan had even then been brought, under the skilful superintendence of the viewer, Mr J. Daglish, M.E.

The three other systems now all in use are, the endless *chain* system, the endless rope system—of which there are two modifications, not reckoning as a distinct system the endless chain plan of South Wales—and the system of single rope planes. In all of these the full corves are seized by the rope or chain at the required point, dropped off free, either by detachment, or by cessation of the power at the required points, and the empty corves are brought back by power. A boy is needed to each train, and, as at Hetton, the highest ingenuity has been exhibited in devisal of the methods by which detachment from a constantly running rope is provided for. To the honour of mother wit be it recorded, that the beautifully simple and effective, though most original and ingenious, form of detaching hook in use at Hetton, was invented by one of these untaught boys who guided the trains of corves; the writer had the pleasure of conversing with the lad, introduced to him with a kindly pride by Mr John Daglish, in the depths of Hetton workings. An admirable account of what has been done up to this time in the way of steam underground haulage may be found in the "Transactions of the North of England Mining Institute," vol. xvii. p. 7, for August, 1868, with very carefully tabulated experiments as to the cost of such haulage work. According to circumstances, and chiefly to the rate of inclination of the trams and the amount of coal hauled per twelve hours, it varies from a little above a penny per ton per mile, to nearly fourpence per ton per mile, of coal drawn.

To these able reports we refer our readers, for our direct object here is not with the methods of leading the coal when "got" underground, but with improvements in the means of getting it.

The methods employed up to the present hour for "getting"—*i.e.*, for detaching coal from its bed, as generally practised in Great Britain—may be said to consist in "holing," under-cutting, or over-cutting (generally comprised under the term hewing) the coal by hand labour; to a limited extent as yet, performing all these or at least two of them, by one form or other of "coal-cutting machinery;" wedging by hand to bring down the more or less isolated blocks of coal; and in many pits blasting the coal down or out of its seat, more or less by gunpowder or other explosive agents.

These methods are equally in use, whether the coal seams be worked by headings, by single or double "pillar and stall," or upon the "long wall" systems; and if we include in our view foreign collieries, more especially those of France, Belgium, and Westphalia, where the seams are in general much more steeply inclined and disturbed than in Great Britain, these methods apply equally to all thick seams however circumstanced. That blasting has been occasionally productive of accidents more or less serious, through the chance of the ignited fuze or the flash of the explosion igniting fire-damp, admits of no doubt. The absolute number of such accidents is small, and their proportion in relation to those traceable to all other causes is unquestionably small; but although that is so, it is the obvious dictate of prudence, if it be found practicable, to avoid blasting altogether, or in at least all "fiery seams." No wise manager can feel at ease in being obliged to sanction the continual use of blasting, where every charge when exploded, may be for ought that he or any one can predict to the contrary, in connection by an invisible and unknown gasiform fuze with the great explosive magazines of fire-damp that may be accumulated in the "goafs" or other parts of the workings.

Prima facie, therefore, everything indicates the desirability, if possible, of getting rid of subterranean coal blasting, on the grounds of humanity and prudence.

But let us look at the matter a little more narrowly in the light of practical needs, &c. Drift-ways must be run into the coal, whether thick or thin, in order to reach and work the seam. These are often miles in length; unless in the exceptional cases of the very thickest seams, the headway required by the drift-way, heading, or rolley way, which is from seven to nine feet, obliges more or less of the coal roof or coal seat, or of both, but generally of the first only, to be removed. This is very frequently composed of hard grit stone, or of "clunch," or other argillaceous or arenaceous material scarcely less hard. For the excavation of these primary works, in nearly every colliery, gunpowder, or some equivalent for it, is indispensable.

Again, there are certain coals which are themselves so hard that (as yet at least) no one has even suggested any way by which they can be dislodged from their beds but by means of blasting.

Such is the case with much of the American anthracites, with some of those of the European Continent, and, above all, with the pure anthracite of the Kilkenny coal-field in Ireland, which contains about 97 per cent. of pure carbon, breaks with a vitreo-conchoidal fracture, and is almost as hard and difficult to dislodge as the rigid carboniferous limestone in which the seams occur, and to the "roof and seat" of which the coal is obstinately adherent.

There are, therefore, cases in which coal mining must, to the end of the chapter, be pursued by means of blasting, so that we have our views as to the substitution of some other means of dislodgment thus limited at least.

We ought not here to omit to remark, before going further, that there is a wide field open for experiments with other explosive agents than gunpowder, with a view to discover whether some may not be found, and be so exploded, that their dislocating effects may be employed, and yet that any fuze at all, or any flash capable of igniting fire-damp, shall be avoided or abolished.

As to the fuze, there is no longer the slightest practical difficulty or objection on the ground of expense, complication, trouble, delay, &c., in employing galvanic or rather magneto-electric fuzes; and as the igniting points of these are plunged in the midst of the charge, ignition of fire-damp is no longer possible from the fuze; it becomes then limited to any flash producible by the charge; but may not this, too, be wholly got rid of?

Gun-cotton, nitro-glycerine, dynamite, nitro-picric powder, all give less flash, and one probably less capable of producing ignition in surrounding gases, than that of gunpowder, all being fired as usual. But a discovery very recently made in Mr. Abel's laboratory at Woolwich, and since, to some extent, worked out into a practicable form, has shown that the explosive effect of gun-cotton in a given charge may be prodigiously increased in intensity, by firing the charge, not by mere ignition at all, but by ignition and a blow or violent vibratory jar at the same instant. The same thing is no doubt true, and *a fortiori*, of nitro-glycerine. It is thus, at this crude stage of the inquiry, plain that we have the means of employing explosive agents greatly more potent and less capable of spreading ignition to fire-damp than gunpowder, and that we can still further reduce the charges of these more potent explosives by employing a suitable method of firing them.

We may thus reasonably hope to attain for any given use charges sufficient, yet so small that the mere cooling contact of the coal or rock split by them, shall prevent even a very slender probability of the flash, if any, spreading beyond the hole or reaching any point to ignite fire-damp.

Experimental researches to decide the scope and value of such an inquiry appear to us quite worthy of our most advancing and scientific colliery engineers, with the aid and countenance of the Northern or of the South Wales Mining Institutes. Still there remains this incontrovertible proposition, so well insisted upon recently by Professor Warrington Smythe, that where there must ever remain more or less room for doubt as to danger, and that danger such as may imperil many human lives, the judgment of every prudent man ought to be, "get rid of explosives in coal mining altogether, if it can be done." Professor Smythe did not affirm that it could be done, nor do we believe that it can, in all cases. Beyond question the ablest and most successful attempts in this direction, as well as in that at the same time for relieving the heavy labour of the coal hewer, have been those of the contrivers of coal-cutting machines. These, in several forms—mainly divisible into two generic classes, viz., those which *hew* in the proper sense of the word, *i.e.*, chop away the coal by blows with a sharp-ended implement like a pick, driven by power; and those which *slice*, or rather grind away the coal by one or many advancing tools, slowly driven by power, and moved like the cutting tools of a slotting machine—have now been more or less under trial for nearly seven years, and in a few places both in South Wales and in the north of England have been (one or other) brought into successful use; the power employed being compressed air, supplied by a fixed engine above or underground, and the air led along by pipes to the faces of the headings or to the wall faces in work.

What may be done by compressed air as a motive power we need not enlarge upon: it has been abundantly shown at the great Mont Cenis tunnel, of which we have given several notices in this journal. Now, besides the advantages effectuated by this class of machines (we have no intention of going into any critique as to their relative merits), of relieving the coal hewer of the very heaviest part of his labour, viz., the "under-cutting" of the coal, and the owner of by far the greater portion of the coal wasted and destroyed by being reduced to powder by the under-cutting by hand, and limiting the "hewer's" task to the cross cutting of the blocks and "getting down," by whatever means, the masses of detached coal; there are these further advantages—that the "under-cutting" can be effected much more deeply in, from the "face," than is readily practicable with hand labour, and that when indispensable the coal-bed may be "over-cut," or freed from the roof if need be, in the same manner—a thing nearly impossible with mere hand labour. It is, however, a very rare case indeed that any moderately heavy seam of "fat" or flaming coal, or any other but of the hardest anthracite, needs any over-cutting, and that, no matter at what inclination or dip of bed. It almost always occurs that if the coal be effectually under-cut, the mass, thus for several yards in length perhaps and for a depth in from the face of from three to six feet, hanging in air free from its support below, only needs to be cross-cut or "holed," when it breaks off at the rear and from whatever slight attachment it may have had to the roof, and drops by its own weight, and then all that remains is to hew or part it into suitable-sized blocks, so as to load it into the "corves," and bring it to bank. This part of the work is done, partly by the blows of the pick, partly by the "hewer's bar," and in harder coal by driving in iron wedges.

Recently there have been some who have thought that wedging might be much more extensively used in coal mining; and that, in fact, by the application of a much more powerful form of machine-driven wedges, coal might be detached bodily from its bed without the use of blasting, without the use of coal-hewing machinery, or hewing in any form either for under-cutting or holing; and that, in fact, this one new class of tool, either the power-driven wedge or, as its equivalent, the expansion of plungers by hydrodynamic pressure, should become almost the sole and sufficient resource of the collier. This is what we propose to submit here to some slight examination in the dispassionate light of the actualities of the problem sought to be solved.

Five mechanical arrangements for coal-splitting were recently brought before the Institution of Civil Engineers, three of them being principal, and the others only incidental to the discussion upon the original paper by Mr. S. P. Bidder, A.I.C.E., "On Machines employed in Working and Breaking-down Coal."

The machine of Mr. Bidder was described as consisting of a small hydraulic press of twelve tons power, to which was attached a pair of tension bars, bent in the form of a connecting-rod or hinge-strap. These were placed one over the other in the bore-hole, and between them, at the extreme end, there were a clearance box and two metal pressing blocks, between which was forced, by the action of the hydraulic press, a split wedge 15 inches long, causing a lateral expansion of 3 inches. The ram was then withdrawn, and a second wedge was inserted between the two parts of the first wedge, and was forced up until sufficient expansion was obtained to break the coal. The operation could be repeated several times if found necessary. The whole apparatus would weigh about fifty pounds. The hydraulic press was in future to be made of steel, and the ram would be cored out. In practical working, each gang of colliers would be provided with the tension bars and three wedges, while the presses would be under the charge of the men who at present occupied the position of firemen, so that no new class of labour would be introduced. Trials had been made both in the 7-feet and the 9-feet seams at Harecastle; and in the latter, with three wedges, about twelve tons of coal had been brought down in only three or four pieces. It was found that the press could be applied, and the blocks brought down, in less time than was consumed by firing and waiting for the smoke clearing.

The second described machine was by Mr. C. J. Chubb. He thought some more simple and practicable means of getting coal by mechanical power could be devised than the costly, but skilfully contrived, coal-cutting machines. His first idea was to apply wedges, acted upon by hydraulic force, but he was induced to abandon that system, owing to objections to the use of wedges, and to adopt instead an apparatus consisting of twelve plungers, set side by side in a steel bar, which plungers, when acted upon by water from a hydraulic pump, would separate the bar in which they were set from another bar, formed in the shape of a cover upon the plungers. The pressing apparatus was 25 inches long, and it was attached to a hydraulic pump by a tube 2 feet in length, so that it might be inserted into the coal to a depth of about 3 feet 6 inches. The apparatus, with the cover on, was 4⅝ inches in diameter. When, by the action of the pump, the plungers had reached their limit of 2¼ inches, and further expansion was needed, the plungers were readily brought back to their first position, by opening an escape cock for the water back into the partially vacuous close vessel out of which it had been pumped, when a liner could be inserted between the plunger and the cover; and this process could of course be repeated. In practice, however, it was found that the first expansion to 2¼ inches was more than sufficient. It was stated that the collective area of the plungers was 24 square inches, and as the pump could exert a pressure of twelve tons on the square inch, a total pressure of 288 tons could be brought to bear on the coal.

This apparatus had been tried in the South Wales district, where the coal was of the most varied description. It was observed that by the present system of blasting, it occupied on an average two men ten hours to break down and fill into trams four to five tons of coal, of which 20 per cent. was "small," and the remainder much shattered. On the other hand, with this apparatus two men could readily break down twenty tons in an hour, which could be filled, when loosened, at the rate of ten tons per man per day, the whole of the coal so obtained consisting of large solid pieces. Again, by the present system, in order to break down 500 tons of coal a day, from a "four-foot" seam, a "face" of 600 yards was required, whether as "pillar and stall," or as "long work;" whereas with this apparatus the same quantity could be worked from 300 yards of "face." In this way there would be less space requiring to be ventilated, the working operations could be concentrated, and facilities would be afforded for effecting economy in other respects.

We may remark, in passing, that but very little stress can be laid upon these statistics. The amount of coal got per man per shift, or day, can scarcely be thus crudely stated with any certainty at all, and must vary enormously with circumstances; and while it seems here underrated, we must say the possible performance of the hydraulic coal-splitter seems both to want confirmation by actual trial, and in the absence of that to appear overrated.

The third contrivance was that of Mr. Grafton Jones, of Blaina Iron Works, Newport, Monmouth, and is also a hydraulic coal splitter, differing from the former mainly in this—that Mr. Chubb's consists of a central tubular stem, carrying a long row of short plunger plugs along the length of its two opposite sides, like the suckers upon the tentacles of a cuttle-fish, which, being inserted into a 4-inch diameter or thereabouts, jumper or auger hole, the plungers, by pumping in water, are forced out in opposite directions, and in direct contact with the coal. Mr. Chubb's is essentially the same in principle; but one range of plungers is suppressed, and the remaining range of these, in place of being forced out directly against the coal, is forced out against a sort of hollow trough-shaped cast-iron "liner," the interior of which fits the faces of the plungers, while the exterior fits the inside of the auger hole in the coal.

In the course of discussion it was incidentally mentioned that Mr. Joseph Bramah, the inventor of the hydraulic press, had proposed its use for coal-splitting; the form which he suggested having been simply that of an extremely strong bag of reduplicated leather, made waterproof. This in its flaccid state was inserted into the flat-shaped hole prepared for it in the coal, and water was then forced in until the distension of the bag caused the fracture of the coal in the direction of least resistance. The two other splitting methods brought before the institution we need but briefly allude to, as one of these merely placed on record an old device of one of the members for splitting rock or coal, &c., by means of a conical screw of steel, screwed into a split cylindrical wrought-iron nut of considerable length, inserted into the bore hole; while the other was but a suggestion for diminishing the mechanical disadvantage of the oblique action of Mr. Bidder's wedges, by means which the talented suggester himself would probably, on more mature consideration, abandon.

Now, we must make bold to say that we entertain the most entire want of confidence in every one of those contrivances, as machines ever likely to be brought into practical use in coal mining; and we apprehend that every coal viewer or mining engineer who possesses some actual experience in coal working must come to the same conclusion. The proposition, in fact, common to all three contrivances is really this, that by means of large holes, four to six inches diameter, of a few feet in depth, bored somehow into the coal in directions more or less parallel with the plane of the seam, and more or less diagonal to the working face, and by the insertion and use therein of these hydraulic driven wedges or plungers, it is practicable (in the working sense of that word), without any previous other work or preparation, to drive out the coal bodily, while still gripped firmly between its seat and the roof, and cause it to separate and fall in dislocated masses.

We shall not deny the possibility of doing this in some seams and in some cases, with nearly level beds of great thickness, and of just the best quality of coal for its successful application; but we do entirely disbelieve the practicability of so working the vast majority of coal seams in this or in any other country. Coal, whether thick or thin, deposited in water-saturated strata, to whose cavities, rugosities, and bendings it has been moulded beneath enormous pressure for ages in action, is everywhere obstinately gripped between roof and seat. When the seam is enormously thick, and most suitable, in respect to hardness and softness and splitability (if we may coin such a word), it is barely possible that more or less of the coal might be thus forced out of its place, leaving, however, almost certainly in every case, more or less of it adherent to the roof and to the floor. But if the seam be but moderately thick (say four feet or under); if the coal be soft and friable, or if it be very hard, and difficult to fracture; if the roof or the floor or both, be of hard material; if either, or both, be uneven, and pitted at the "coal parting" with them—or if the coal join on direct to the floor or roof or both, without any thin parting seam of vegetable charcoal, shale, or other very fissile material—then we feel pretty certain that such attempt to drag or push the coal out of its place, as it were by the neck, must end in complete discomfiture, so far as rapid and economical working are concerned, assuming that the physical possibility be conceded.

It comes, then, to this, that if we are to split coal out in large blocks, with small waste by dust and powdered coal and slacks, we must free it first either above or below. We can then split it out, no doubt, but *cui bono?* what will be the use of wedging from behind to split out masses of coal which, when once properly undermined, will rapidly fall by their own weight, and then detached from roof, floor, and "heading" or "wall," leave nothing to be done but to break them up smaller, and to sizes to be loaded on to the "corves," all which must be done as at present by hands in any case? This is the case with all moderately thick coal beds, even though they be perfectly flat and level. It is much more the case with highly inclined beds, like those of Belgium and Westphalia, which are worked on the long-wall system from the under side, and along "the strike" of the beds, and from which the blocks of coal, once under or over cut, fall of their own accord, often but too readily and suddenly.

But at this time of day there is probably not an intelligent and well-informed coal viewer in Great Britain (and few of these gentlemen are not both one and the other) but is prepared to admit that under-cutting by coal-hewing machinery of one sort or other is already an accomplished fact, and that time, and not a long time, alone is needed for the wide-spread introduction, as a matter of necessity, of coal-cutting machinery in all our great collieries. Well, then, we have the coal cheaply, economically as regards the waste coal, rapidly, and deeply under-cut; we cannot get rid of the coal hewer, he must be there to direct and to fashion to a portable shape the huge blocks got out, he is on the spot therefore, to hole or cross-cut the huge blocks as these drop from the roof, and by their own weight part off from the face of coal behind; of what use, then, are the hydraulic wedges or hydraulic plungers at all? They appear, under such conditions where alone they can be applicable, as simple surplusage, for no sane man, we presume, will imagine the physical possibility of forcing out *thin-seam* coal while still gripped both by roof and seat.

Thus much for splitting in general, and without reference to the mode of attempting it. Granted the necessity and the utility of the plan of working, we are very far from being satisfied that any one of the actual arrangements proposed even approaches the best possible, or a workable form at all, for the purpose.

We shall not go into details, but merely ask our professional coal-viewing readers to ponder, in a practical mood, upon the facilities, or the contrary, for working straight and cylindrical holes of four to six inches diameter into various sorts and thicknesses of coal, and under the various and often complicated conditions in which the workings are circumstanced.

We ask whether these hydraulic wedges or presses, said to be 50 lbs. weight each, but actually much nearer probably, if ever brought into a workable form, to 150 lbs. weight each, and which *must* be carried about and *manually* handled, will prove convenient? Whether in friable and compressible coal much more of the power expended will not be absorbed in crushing the coal close by to powder, than in splitting off that more remote? and whether, in any one of the arrangements, but most of all in Mr. Bidder's wedges, a prodigious proportion of the power expended be not necessarily always wasted? and if power be wasted in any machine, time is wasted, and money is wasted.

If a choice is to be made between hydraulic-driven wedges and hydraulic-driven plungers, between the power of the hydraulic cylinder, which may be at once brought up to any pressure we like per square inch, applied direct to the coal, or to that awkwardly exalted by the interposition of wedges—we are compelled to give our voice in favour of the simple and direct application of the hydraulic plunger. All wedges driven by pressure act at enormous mechanical disadvantage as wedges; work is uselessly absorbed in friction, and the loss so produced is greater as the angle of the wedge is less. The very essence, it may be said, of the wedge as an efficient mechanical engine depends upon its being driven, *not by pressure, but by blows*. At each blow the friction of rest, constantly encountered by the wedge driven by pressure, is by the sudden jar converted into the friction of motion, the coefficient of which for the same surfaces and pressures is usually not much more than one-half of the former.

With the hydraulic cylinder applied direct, the real limit to the intensity of the pressure per square inch of pressing surface is that of the crushing coefficient of the coal. That makes the limit really a low one, and hence we will hazard the conjecture that were these coal-splitting contrivances likely to be called into actual use and practice, it would probably be found that perhaps the very best form in which hydraulic pressure could be applied at all, might prove to be in that of a modification of Joseph Bramah's original leathern water-bag. We have nowadays materials and methods at hand for the construction of flexible or partially flexible bags, into which water could be forced to all the pressure the coal would safely bear without crushing, such as were unknown in his day, and the structural problem presents few difficulties to the mechanical engineer. Upon the whole, and in conclusion, however, we continue to believe, that it is to the perfectionizing of coal-cutting machinery, and not to coal-splitting instruments, even though far better designed than any that we have been noticing, that we ought to look for attaining the unquestionably most important ends, of saving risk by limiting the use of explosives, cheapening our coal-getting, and economizing our coal itself.—Ed.

CELESTIAL PHOTOGRAPHY.

By Howard Grubb, C.E., M.R.D.S., Mem. Inst. C.E.I.

I have been requested to give a description of our experiments in celestial photography conducted with the great Melbourne telescope during its temporary erection at Dublin. This, from the limited number of experiments which it was in our power to make, I should have some diffidence in doing, were it not that the scale upon which they were conducted being altogether unprecedented, and their success, considering the temporary nature of the apparatus, to say the least, remarkable; an account of these experiments cannot fail to prove interesting to a large number of readers.

The experiments originated in the great doubts which had been expressed of the practicability of photographing with this instrument, without being provided with some huge scaffold apparatus to reach the mouth of the tube. The reader will recollect that the instrument (Vide *Practical Mechanic's Journal*, Dec., 1868) is a Cassegrainan reflector, in which form the eye is applied at the lower end, while the photographic apparatus must be mounted at the upper end of the tube* to receive the primary image as formed by the great speculum. This scaffold would require to be thirty-five feet high, and would be as unmanageable as ponderous.

My father considered the scaffold unnecessary, as the tube could easily be lowered to receive the plate, and raised again to position for exposure. This was objected to as taking for such an instrument a considerable time to effect, especially as the tube would require to remain stationary after being raised until all tremors had subsided before exposure of the plate. Therefore, these experiments were instituted to prove not only the possibility, but the great convenience, of working the photographic apparatus in the way my father originally proposed; in fact, it has been found that the slide containing the prepared plate can be placed in position, the telescope raised and pointed to the object, and all tremors allowed to subside, in less time than it would take a person to climb up thirty-five feet of scaffold—not to speak of the labour and even personal risk of such an operation.

It is but right to state that any doubts which had been entertained as to the practicability of such a course as I shall presently describe were immediately dissipated on inspection of the instrument; for, instead of the great labour which it was supposed would be necessary to work an equatorially-mounted telescope whose moving parts weighed eight tons, experience showed it could be moved by a child, and, as to time, ten or twelve seconds would run it up to the ordinary altitude of the moon, and two or three would be sufficient to allow all tremors to subside in the tube.*

So many popular descriptions and engravings of the telescope are now going the rounds of the illustrated and scientific journals, it is unnecessary for me here to enter into any details, except of such parts of the instrument as were especially designed for photographic operations. In these the clockwork of an equatorial telescope plays a very important part, and unless it be competent to do its work well, it is quite impossible to expect any success. The governing or regulating portion of the clock of the great Melbourne telescope is fully described elsewhere, so I may at once pass on to those parts which have reference to the adjustment of the speed.

The clock, in what we may call its normal state, is adjusted to carry the telescope at sidereal rate. But at a convenient part of the shaft which connects the clock with the telescope this shaft is divided, and by means of a system of six differential wheels—three on the shaft and three on the countershaft—the simple movement of a lever changes instantly the rate of the telescope from sidereal to mean lunar, the rate of the clock itself remaining undisturbed.

For the final adjustment of rate, either to that of actual lunar rate *pro tem.*, or to that of the governing part of the clock, the latter is provided with an apparatus actuated by a lever traversing by hand over a graduated arc, which affords the means of making the final adjustment for rate in all cases with extreme accuracy. By this arrangement it will be seen that all alterations of rate in movement, either great or small, are made almost instantly, and without stopping either the clock or the telescope.

In adjusting, finally, a tentative process was used; but it is proposed to draw out a table of the values of the divisions corresponding to the motion of the moon, as given in the *Nautical Almanac*, and then both adjustments may be made instantly by reference to the *Almanac*.

No provision was made for counteracting the motion of the moon in declination. It was at first proposed to attach a piece of mechanism for this purpose; but the exposure proving so very short (about two seconds) it was then considered unnecessary, as the greatest movement during that exposure would be not more than 0·00066 of an inch.

The apparatus which we attached to the telescope for the photographic operations was of the most temporary character, and it is unnecessary that I should describe it particularly here, as I hope soon to be able to communicate a full description of the very complete apparatus we are at present constructing to follow the telescope to Melbourne.

The temporary apparatus consisted mainly of a tripod frame, partly iron and partly wood, which was bolted to the upper end of the lattice tube, the apex of which stood out about two and a half feet. On this was mounted a sliding tube with rack and pinion, carrying a frame into which the *châsse* of a photographic camera slid. Through the body of the sliding tubes the day eyepiece of a telescope was inserted, which could be brought to a focus on the plate from behind. There also was mounted in front of this frame, and quite independent of it, a flap shutter, which could be worked by a person on the ground with a pair of strings and parallel levers attached to the lower end of the tube.

We had heard so much of the necessity of procuring chemicals very pure and in very perfect order, to obtain even moderate rapidity, and having only taken the precaution of fusing the silver for the bath, and in other respects using our ordinary chemicals, the first picture I exposed thirty seconds on a three-fourths moon, on January 11. This being quite overdone, I tried successively fifteen, ten, five, two, and one, and finally

* Necessarily, as in the Cassegrain construction, the secondary image (received at the lower end of the telescope) is so much enlarged, and consequently diminished in intensity, as to render it insufficient for photographic purposes.

* Some assertions which have appeared in a London contemporary relative to the stiffness of the tube could only have been made in profound ignorance of engineering science. If the reader would care to form an idea of its rigidity I can give him these data. The tube being horizontal, 112 lbs. was hung at its end, twenty-five feet from the point of support. The deflection thus produced = 0·005 inch; and I may also mention that its rigidity appeared so remarkable to a civil engineer who inspected it, that he afterwards adapted the same principle in a design for a portion of a lighthouse.

settled on one and a half second as the best exposure. But then arose another difficulty. If sufficient exposure was given to bring out the faint details of the terminator, the brighter edge was completely overdone. On January 27 two plates were exposed on the crescent moon, but nothing satisfactory was obtained, owing to a considerable mist; but on February 1 we arranged the shutter so that we could expose the faint terminator as much more than the bright edge as we desired. The actual practice of the operation was as follows:—

Some time during daylight the eyepiece (which acts the part of a delicate focussing glass) was adjusted to correct vision on a piece of fine ground or collodionized glass, placed in the position of the prepared plate in the dark frame; when sufficiently dark the telescope was pointed to some bright star, which, being low, or for some other reason, proved convenient. On looking through the eyepiece the image of the star was seen on the collodionized or ground glass. This then was brought to the best focus by the rack and pinion, and clamped by a pair of tightening screws.

The telescope was then turned on the moon, and the clock adjusted in its rate by the apparatus before alluded to. The telescope being accurately pointed * to the moon, was then unclamped and lowered in declination until the upper end came to a convenient height for a person to take out and put in the dark frame. The plate being prepared and inserted, the telescope was raised again in declination to position, which operation required about ten to twelve seconds. This required no movement in right ascension, as the clock had in the meantime been carrying the telescope in that direction. About five minutes were allowed to elapse to insure the total subsidence of any tremors in the tube, and then the lever for opening the shutter was slowly and steadily moved, the operator watching the process through the hole in the large mirror.

By arranging the shutter as before described, the exposure of the several parts was quite under control, and, while the faint terminator was given two seconds' exposure, the bright edge got only from a quarter to a half second. The telescope was then lowered again in declination and the dark frame taken out, and a fresh plate inserted. In this way about one dozen plates could be exposed in an hour with one assistant. The chemicals, with the exception of the fusing of the nitrate of silver for the bath, were the ordinary ones of everyday use—collodion bromo-iodized, iron developer fifteen grains to the ounce, and pyro. of two grains to the ounce for intensifying. Great care was necessary to keep the image from getting too intense.

As regards the relative capabilities of this telescope and Mr. De la Rue's for photographic purposes, the size of image given in Mr. De la Rue's telescope is equal to 1⅛ inch, that given by the great Melbourne telescope equals 3⅜ inches, just three times the diameter and nine times the area; but the area of the speculum of the great Melbourne telescope is thirteen and a half times that of Mr. De la Rue's, and therefore the image, although nine times the area, is about one-half more brilliant.

Such are the results we have so far obtained; but we do not wish it to be understood that we consider the photograph referred to to be the best, or anything like the best, that can be produced with this instrument; for it should be remembered that the apparatus was quite a rude and imperfect one, and our work with it has been that of days, not years, so that it affords but a very imperfect idea of the magnificent results that may be expected when the apparatus is in working order, under M. Le Sueur.

A few words as to these results, and the probability of any improvements, may not be amiss here.

I believe it is a conceded fact that no photograph that has ever been taken of the moon has revealed those finer details and test marks familiar to a practised observer on a fine night. It will be interesting to investigate the cause of this. In the first place, we have a certain amount of "structure" or "texture" in the collodion, which, when the photograph is magnified or enlarged to an extent sufficient to see these delicate details, seriously interferes with the detection of such, even if they should be there; hence one of the advantages of using a large telescope and getting a large primary image, which, of course, does not require so much enlarging to bring it to the same amplitude as the smaller. There are two directions, therefore, to be followed in surmounting this difficulty:—First, the obtaining of a collodion as structureless as possible; and, second, the working with a telescope as large as possible in order to obtain a large primary image.

The next difficulty we come to is the *great* difficulty of the celestial photographer. I refer to the unsteadiness of our atmosphere. The effect produced by this unsteadiness in the atmosphere is but too well known to any persons who have worked with even moderate-sized telescopes, but the difficulty increases rapidly with the power of the instrument. I wish, however, to show how this affects the photographic operations more than the visual observations. The effect of this unsteadiness on looking through a telescope has been compared by some to that produced upon objects (such as pebbles at the bottom of a brook) by running water, by others to that produced by the proximity of any heated body; but whatever it may be compared to, the effect is that of an undulatory wavy motion of the several points of the object. Occasionally there seems a slight lull, so to speak, and objects are seen more clearly, and sometimes for one single instant a glimpse is obtained of amazing clearness, which the next moment is swallowed up in a mass of vibrations. Hence, then, we can see how it is that this unsteadiness interferes more with the photographer than with the visual observer. The object may be considered to be to a certain extent in motion; such motion does not interfere much with visual observations, but I need not tell photographers that it does so sadly with photographic observations.

Again: the eye is able to eliminate (if we may use such a term here) one fine moment, if there be such, in the whole period of observation, while we must consider the photograph as a fair average of the condition of the object during exposure. If the unsteadiness of the object were simply a matter of motion or vibration, there is no doubt that, if we could diminish the time of exposure below that of one vibration, any further diminution would increase the distinctness of the resulting photograph.

That it is not purely a matter of motion is very evident, but that this character enters largely into the question there can, I think, be but little doubt. This would tend to show that it is desirable to reduce the exposure as much as possible. Such reduction, however, I consider, would have little or no effect until a certain point be reached, determined by the rapidity of the vibratory motion. For example: suppose you wished to photograph a seconds pendulum in motion. It is very evident that, whether your exposure were one, two, three, or a hundred seconds, the moving pendulum would be equally confused in the photograph; but if you reduce the exposure to one-half, one-fourth, or one-eighth of a second, you will have respectively twice, four times, and eight times the distinctness. On this point I quote the words of Mr. De la Rue, who, from his great and lengthened experience on the subject, must be considered the first authority. "I am persuaded," he says, "that the proper direction to be pursued in developing astronomical photography will be to increase the aperture of the instrument in relation to its focal length, and to diminish the time of exposure as much as possible by always improving the chemical part of the process.

Whether this great increase of sensitiveness will ever be obtained is a "nut for photographers to crack;" but if this great rapidity cannot be obtained for the moon, there is no reason why it could not be obtained in the case of the sun, when the difficulty lies in the excess of light. As regards the other matter mentioned by Mr. De la Rue, viz., increasing the angular aperture, I have already shown that we have done something towards accomplishing it, the image of the great Melbourne telescope being about one-half more brilliant than Mr. De la Rue's; but the difficulty of accomplishing this increases much with the size of the instrument.

One more point I would remark on. Referring to the rarity of those favourable moments of observation, it will be readily understood that many photographs may be taken without catching one of those moments. Hence it is greatly to be regretted that there is not some means set on foot to produce photographs of the moon systematically on every possible opportunity. M. Le Sueur may, and will, do much with the great Melbourne telescope, for the nights upon which the moon is a conspicuous object are the worst for his nebular work; but it is surprising that in England, where so many gentlemen have telescopes adequate for the work, so few have taken up this interesting branch of the photographic art.*

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* This was effected by means of the finder telescope.

* The photograph of the moon referred to above, and also a series illustrative of the great Melbourne telescope, are being published by Messrs. Pumphrey Brothers, of Birmingham.

ENGINEERING EDUCATION.

(Continued from p. 336.)

"THESE young men during three years have the run of the office or workshop, and if they are intelligent, towards the end of their pupilage often have opportunities of seeing actual work in the field, or of designing some parts of actual machinery, and of assisting in the erection of more or less important works. No one teaches them anything; but they have the opportunity of seeing how some actual work is done; they see just how much mathematics is absolutely required, and they pick it up. They see how workmen are managed, and learn their habits; they are brought into contact with the exact class of work which they will have to perform, and they know that unless soon they are competent to do this work, they will not have a chance of employment. The one point for them is, to convince their masters that they are useful, and hence, notwithstanding their ignorance at starting, the neglect in which they are left during their pupilage, the absence of opportunities for improving their theoretical acquirements, many of them do become useful men.

"The contrast between the two systems is complete: abroad, men have almost perfect theoretical instruction, coupled with a wonderfully good imitation of the real work, so far as design is concerned; they are not brought into contact with the execution of those designs until they begin to gain their bread. In England, the theoretical instruction is wofully deficient, but the abler men are allowed to design real work, and they watch the execution of that work in many stages. Abroad, competitive examinations keep out incompetent men; in Britain they are weeded out by the result of the struggle for existence. Abroad, great numbers pass through the same school, making the same designs, in great variety, under the same professors. Here, each man sees different work, but of a limited kind.

"Before deciding which system is the best, or what modification of the two is desirable, we ought to form some idea of what the work of an engineer is.

"As a civil engineer, the young man is called upon to design small works, such as bridges or culverts, according to some well-established type—little originality is wanted, and just so much theory as will allow him to make safely the slight modifications required to meet each case; he superintends the execution of work by contractors, and must know good from bad work when he sees it; he must have such a knowledge of mensuration as will allow him to certify exactly the quantities of work done by the contractor. He must be able to survey on occasion, to level with great rapidity and accuracy, and to set out work in the field. He must have such a knowledge of the world as will enable him to deal pleasantly and firmly with workmen, contractors, and proprietors on whose land the works are being constructed. Above all, he must be a thoroughly honourable man, wholly above suspicion of taking bribes from contractors, of cooking his work, of concealing any blunders he may make, or of absenting himself from his duties.

"Colleges cannot teach young men all these things, and my own experience has confirmed the conclusion, that a gentlemanly man of fair education and intelligence, after working as a pupil for three years in a civil engineer's office, is, for subordinate positions as a civil engineer, a more useful man than the pupil of a foreign school.

"For a mechanical engineer the case is different. The younger men in factories have to design machinery frequently of one type, but nevertheless varying so much from year to year, that a sound knowledge of mathematics, mechanics, and physics, is of the greatest importance to them; consequently as draughtsmen or designers we find foreigners employed all over the country. And *à priori* I would rather engage a foreigner to carry out my ideas in designing a new machine than a young Englishman of equal standing, especially as most of the foreigners complete their education by working in a shop for a short period.

"As they rise in their professions, engineers are called upon to display higher and somewhat different qualities. The civil engineer may be called upon really to design great works and novel works; and here Englishmen feel sadly the want of a sound theoretical training. But even in the higher walks of the profession, design and invention are required much less than is usually supposed. The leading engineer must be a man of good business habits, able to advise the directors of great companies prudently as to the probable cost and revenue of proposed works. He must have the head of a lawyer in drawing up specifications and revising contracts. He must get into no scrapes by trying new-fangled schemes. He had better have no patents, which are generally supposed to be simply plans for getting money without giving any material equivalent. He must be able to choose his subordinates wisely, and keep them in good discipline. In a word, he must be a man of great *common sense*

"As a mechanical engineer, or as a contracting engineer, a knowledge of trade, a keen eye for economy in details, and a thorough practical knowledge of the properties of the materials he employs, must be added to the above list of talents; and when we reflect how very few of the above qualities can be taught at colleges, we understand how it is possible that our engineers should justly take a high rank in the estimation of the world.

"You will long since have anticipated my conclusion—that *there is no reason for abandoning our system of apprenticeship or pupilage to substitute for it the foreign plan of large special colleges*, even if we could hope to create colleges of equal merit with those formed abroad.

"But this conclusion, instead of leading us to sit down wrapped comfortably in a veil of blinding self-conceit, ought rather to urge us to work with the greater vigour at removing the acknowledged defects of the British plan. We have not to construct the whole edifice anew, we have only to put on the cornice-stone.

"Our defect is the want of a good knowledge of the theories affecting our practice.

"It must be admitted that of this knowledge we possess far less than is necessary. By dint of sheer hard thinking and repeated trials we somehow do solve most problems; and the plan of Brindley, who used to go to bed when he was posed, and think steadily for a day or two, is by no means a bad one. But our success costs a vast expenditure of money and of brain which could be turned to better purpose if we knew how to calculate the results to be expected from a given combination with some certainty beforehand. And not only does our ignorance cause much wealth to be wasted by the community in useless trials, but it prevents the trial of many new schemes, because the engineers or managers to whom they are submitted feel that they have no means of judging beforehand of the probability of success, so they, wisely in their generation, think they had better stick to the old plans, and in nine cases out of ten they are right; but the rejection of the tenth case is a dead loss to themselves and to the country. I do not know which is the sadder sight —the hard struggle which awaits the true inventor before he can introduce his invention, or the miserable efforts of the vast crowd of ignorant men whose foolish fancies load the shelves of our Patent Office. Poor men! they devote their fortunes, their time, their very lives, to the nurture of some mocking shadow, born of conceit and ignorance—that ignorance which it is our business to banish from the land.

"How much theory, as it is called, does the engineer want to enable him to judge soundly and design correctly? Certainly much less than is given abroad. At each college I visited, I asked what application these higher branches of mathematics and mechanics had to the practical work of an engineer. The first answer I received was that they were useful as gymnastics to the mind. I answered that I thought the mind might be more usefully exercised, and again asked what application could be made of this knowledge. The second answer agreed in three cases. Turbines, it appeared, could not be correctly designed without a very high theoretical training indeed; and our British turbines came in for a sneer. I used the vortex-wheel of James Thomson of Belfast as an answer, but had to confess my answer was not much to the point, as he is a most distinguished theorist.

"Well, to me it hardly seems worth while for an engineer to spend three years in studying the higher branches of mathematics if these only find their application in turbines. Unquestionably these studies are necessary for the original investigation of novel problems; but the engineer in large practice will never have the time or inclination for such work as this, which will invariably be better done by such men as Sir William Thomson, Clerk Maxwell, Professor Rankine, or my colleague Professor Tait.

"Those engineers whose natural bent lies towards such studies, will find them doubtless of great advantage; but in the general scheme of education for the profession they need not be included. This being so, I have no doubt that the *engineering student of average ability might acquire a sufficient knowledge of theory before his apprenticeship begins, or during its course.* The very entrance-examinations required by the foreign colleges are a proof of this. These examinations are passed by young men of seventeen, eighteen, nineteen, and if our pupils could enter on their apprenticeship as well educated as the foreigners when they enter their special schools, I am convinced that the British would in every respect be far superior to the foreign system. Our engineers would then start in life with a good knowledge of algebra, trigonometry, mensuration, drawing, the elements of physics and chemistry. The few who had the turn for higher mathematics could pursue their studies in after life, but all would be saved the weary time now lost in offices by zealous men trying vainly to understand the simplest formulæ, and gradually picking up through practice the power of mensuration, and of representing ordinary geometrical forms by mechanical drawing. In addition, it would clearly be of great advantage that they should, before being brought in contact with practical work, have had their attention drawn to the manner in which all these branches of knowledge are applied to the solution of practical problems, and this is the view I take of the duty which I have personally to perform. It is impossible in a single course of lectures to touch even cursorily on all parts of the vast field now claimed by the engineer as his domain. If it were possible, the mere cursory mention of the innumerable problems would be useless to the student; but it is quite possible to show the application of the theory of mechanics to the calculation of the strength of materials, and to the dimensions of the elements of machinery; it is quite possible to point out how in practice the stress to be borne by the various parts of structures comes to be determined. The practical application of the theory of energy and of work can be shown by a few examples chosen among the many engines from which man derives motive power. The manner in which estimates are made, specifications drawn, and contracts framed, can be indicated by special examples. Above all, it is possible to inculcate the true principles of economy upon the mind of the student, who should never forget that the object of the engineer is not to display his ingenuity by the production of ingenious devices, but to use his judgment and invention so as continually to endeavour to increase production at a diminished cost.

"Thus, by first explaining the nature of the elementary materials and forms with which the engineer has to deal, and by then analyzing the construction of known practical examples, I hope to send my students to the offices and workshops of my fellow engineers really well prepared to make a good use of their opportunities, and able to apply to the endless variety of problems which they will encounter, those principles, the application of which they have learned in a few cases here. If, moreover, the students will attend the classes of natural philosophy, mechanics, mathematics, and chemistry, if they will take advantage of the facilities given for acquiring a knowledge of drawing, of surveying and levelling, and of inspecting, under my guidance, practical examples of works, machinery, and processes of manufacture, we shall, I think, do much to solve the problem of how to improve the education of our young engineers in matters of theory without sacrificing the valuable element of practice obtained by the system of pupilage; *and this work can, I believe, be far better done at a university than in any new special schools.* You observe that I count upon having the work done even more by my colleagues than by my own exertions—I wish my engineering pupils to owe quite as much to Professors Kelland, Playfair, Tait, as to me. Does any one think that a new polytechnic school, started in rivalry with the university, could count on such professors as these? I do not; and if the new school did attract such men, it would weaken our ancient universities, in which we all feel so legitimate a pride. Abroad, I saw this in action. At Zürich, the polytechnic school dwarfs the university; and in French universities, the scientific teaching has fairly been extinguished by the polytechnic school. Hardly a student of science attends a class in the universities. The reason given me for the separation was the want of elasticity in the foreign institutions, which, owing to their charters or their prejudices, could not so change their practice as to meet new requirements. We in Scotland are wiser. The domain of exact science grows day by day, and instead of jealously denying honour to new branches of learning, instead of shutting their gates to the students of new professions, the Scottish universities aspire to lead the way, and to guide the student on every path that leads to knowledge.

"Surely this is preferable to the extinction of ancient institutions, with their grand traditions. Moreover, though I am one of those who believe that science will more and more become the instrument of culture for a large class of minds, I am far from insensible to the great value of that form of culture which hitherto has been given almost exclusively by classics and metaphysics. I have said enough to show that the leading engineer must be no mere calculating machine, but that he requires a breadth of knowledge and openness of mind which can seldom be acquired by those who are ignorant of literature, and who have not obtained at least a distant view of the great sea of metaphysical speculation. For this reason, if for no other, I would fain see young engineers pass through such a university as this, famed above all for its influence on the studies of ethics and mental science.

"If universities are to supply methodical instruction for new professions, so as to render unnecessary the erection of special schools of narrower scope, they must not only found certain chairs, but must group into well-considered courses of study the subjects required by the students of these new professions. Consider how unsatisfactory the education of medical men, for instance, would be, if each student were simply free to follow what courses he pleased, in any order he pleased—if there were no curriculum to guide him, no methodical examination testing his acquirement, no degree certifying the measure of his attainments. Engineering is a younger profession, but one no less well defined or less recognized by the world than that of medicine, and a curriculum or methodical course of study, examinations, and *degrees or diplomas of some kind are really as necessary to insure methodical study by the engineers as by the doctors of medicine or the doctors of law.* A natural, and indeed a healthy, aversion exists to the creation of new degrees, or even new examinations, diplomas, and certificates; but unless some distinct aim less vague than future and far-distant professional success be held out to the student, I fear it will be hopeless to expect him to follow that methodical course of study which I regard as essential. Diplomas of engineering are no novelties abroad; they are granted by all the large and successful colleges; they are the object of a most legitimate ambition, and testify to facts which can be ascertained with certainty. No diploma could be granted by this university certifying that a man who had only studied here was fit to practise the profession of an engineer; a diploma following on college studies ought only to declare that the student is fit to enter the office or the workshop with advantage to himself and his employer; but there is no reason why, after some years of practical work, the engineer should not return to the university, and by passing a voluntary examination, both in matters of theory and of practice—such an examination as is actually conducted in Germany—obtain a degree or diploma which should really be a guarantee that in certain branches he was a competent engineer. The arguments in favour of an engineering degree may be thus shortly stated:—The profession is well defined; the studies required by its followers are of a scientific kind, well suited for collegiate examination; a motive for systematic study is urgently required; and, lastly, a means of distinguishing themselves is earnestly desired by young engineers on the termination of their pupilage. Now, personal distinction is wholly denied to the young engineer; he works for others, and the merit of his work falls to the credit of his employer, who is responsible for it to the outer world; some means of distinction, such as is afforded by a degree, would greatly tend to induce men, after leaving the university, to continue their studies. I really know of no objection to the creation of a degree or the granting of a diploma, except that it is a novelty in Great Britain, and might be misused by inferior institutions.

"When all this has been done, as I hope it will be done, our difficulties are far from being at an end. We must not only provide a methodical examination, but we must induce students to avail themselves of it. As I said before, foreign colleges are full of students, because the only paths leading to practice lie through these colleges, and if the engineering students at our universities are to be numerous, the universities must become the recognized portals of the profession. We can do something by giving sound instruction, but the effect of this on the public mind must necessarily be slow, for the fruits of good teaching, given to a small number, can only be slowly felt. We may therefore call upon those outside our walls, who have faith in scientific teaching, for assistance. I cannot show better how this might be done than by referring to some of the resolutions arrived at by the committee of the London Society of Arts on technical education. This committee, composed of men of great weight, recommend that the government and the leading civil or mechanical engineers should co-operate with the universities in examinations for diplomas or degrees. Such a co-operation would guard us against a species of Dutch auction, in which inferior colleges might possibly engage, giving the new degrees with more and more facility, for continually smaller acquirements, in the hope of attracting pupils. The committee further recommend that the engineers and the government should give a practical value to the diplomas or degrees granted with their co-operation, by the following steps:—1. Reducing premiums to intending pupils holding diplomas; 2. By giving weight to the possession of diplomas by candidates for employment; 3. By granting distinct privileges in connection with the great professional institutions; 4. Government might give official value to the diplomas, by allowing these to represent a given number of marks in competitive examinations; 5. By putting at the disposal of universities which give diplomas of recognized value a limited number of nominations annually; 6. and lastly, By acting with the same liberality which government has shown in endowing this chair; by assisting old and new endowments, where private subscriptions or donations prove the value set on the instruction proposed or given.

"When we find a committee composed of such members of Parliament as Mr. Samuelson and Mr. Acland, such men of business as Sir Daniel Cooper and Mr. Hawes, such professors as Williamson, Huxley, and Hirst, and Miller, such engineers as Hemans and Pole, all concurring in their readiness to establish and recognize diplomas of engineering, we may surely admit that the time is ripe for the creation of such diplomas, and the recommendations made in their report may safely be acted upon by the leading professional men, by government, and by this university. If engineering departments in universities come to be supported in the manner proposed, the great bulk of our young engineers will soon pass through our science classes, and the profession be relieved from the degrading charge of ignorance of first principles, and of the theory of their application. I am sanguine enough to believe that these things will come to pass, and hold enough to hope that this university will lead the way.

"Some difficulty may be found in leading a few of the older members of our profession to recognize the value of scientific study. It will be our business to convince them of their error, and, when convinced, no body of men will evince greater liberality or zeal in furthering the interests of the profession, as has been recently proved in Manchester by the endowment of the chair in Owen's College, and by the splendid munificence of Mr. Whitworth.

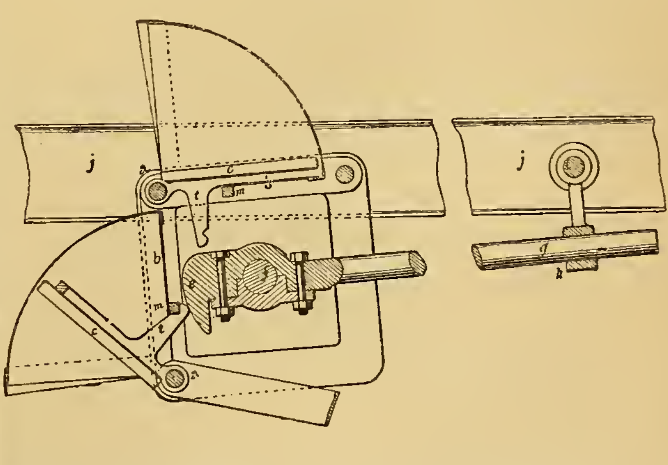
"In conclusion, let us consider the path over which you have followed me. We found in the polytechnic school of France and the English system of pupilage two wholly different plans, aiming at one end, each with grave faults. Intermediate between the two, I described the action of the Ecole Centrale of Paris and the polytechnic schools of Germany, admitting their success. Nevertheless, after reviewing the work required from the engineer during his professional career, I argued that in Great Britain we should not tamely copy institutions which do not fit with the established custom of this country, but should rather endeavour to develop our own method, successful in the main, by adding to the practical teaching given by pupilage that theoretical preparation now wanting. I endeavoured to show that this preparation could be given before the age at which men enter works or offices, and showed in illustration that foreigners, at that age, did pass examinations of far greater difficulty than those which are now held by Government to determine the selection of engineers for civil posts in India. Next came the question whether special schools or ancient universities are best fitted to give this preparation, and I can hardly doubt that your hearts will re-echo, with just pleasure, the arguments, which reason alone dictated, in favour of our ancient College. Lastly, I indicated the nature of the support which would most effectually insure that the opportunities now granted shall be effectually used. But I have not yet named the main source of support on which I count, the main grounds of my confidence in success—the zeal and energy of the Scottish student.

"I have spoken tamely and coolly of the life and duties of an engineer; for it was necessary to reason calmly in weighing the merits of rival systems. I spoke of common sense as the cardinal virtue of an engineer, and we in Scotland fairly claim, I believe, more than the average share of that commodity. But more than this is required. No one who, as a mere business speculation, coldly chooses a profession, will ever rise to great eminence. Zeal and devotion to the work are wanted. The profession of an engineer offers ample scope for the exercise of such feelings. We see him taming Nature's forces till they become his servants, creating wealth for nations by the exercise of invention, commanding armies of men, who, labouring to their own benefit, yet shape the work till it embodies the idea of one mind, for whom Science herself toils as a handmaid—who then shall say that the work of an engineer, which can be thus described, is not a fit subject for *enthusiasm?*"

COUVREUX' BUCKET FOR DREDGERS AND EXCAVATORS.

M. A. Couvreux, the contractor for the works of the Suez Canal, is the inventor of a new arrangement of bucket for dredging and excavating machines, the object of which is to facilitate the discharge of its contents, and prevent the clay and other plastic substances adhering to the bucket—a defect to which the ordinary buckets are very liable. M. Couvreux constructs his buckets with a movable back, as shown in fig. 1. The bucket is capable of turning on the bolt, *a*, common to two links of the dredging chain; it is also provided with a side or partition, *b*, which does not extend the whole height. The movable back, *c*, is fixed on a frame composed of three square iron bars, and the middle bar has a projection, *t*, forged on it. This projection is steeled at its end, which bears on the cam, *e*, in order to render it more durable. The cam, *e*, is secured in its place around the shaft, *f*, by means of two bolts, as in an ordinary eccentric. In order to prevent the cam from turning with the shaft and the buckets, it is provided

Fig. 1.



with a rod or tail, *g*, passing through a square guide, *h*, which is suspended by two arms on a shaft, *i*. This shaft passes through the chain guides, *j*, and as the arms which carry the tail guide, *h*, are capable of turning freely around this shaft, the cam will always be in position, whatever may be the length or inclination of the chain guide, and thus both the cam and the chain guide will be rendered capable of turning round their respective axes, whilst remaining dependent the one on the other. In order to limit the rotatory motion of the movable back the projection, *t*, fixed on the movable back of the bucket, is provided with a notch, which in the rocking motion becomes hooked on to a cross piece, *m*, also adapted to the false back. The operation of the apparatus is as follows:—Suppose that one of the buckets composing the dredging chain has arrived at the top, as shown in fig. 1. Just as it is coming into the position to discharge its contents the projection, *t*, begins to press upon the cam, which lifts the movable back. The load is thus forced out of the bucket, and the movable back returns into the bucket, which descends again, where its new load forces the movable back into its original position. The length of the cam should be so arranged as not to bear against the buckets, as otherwise it would sink them. The projection, *t*, should also be limited in its length, in order to admit of its passing over the rollers of the chain guide, and clearing the collar and tail of the cam.

Fig. 2.

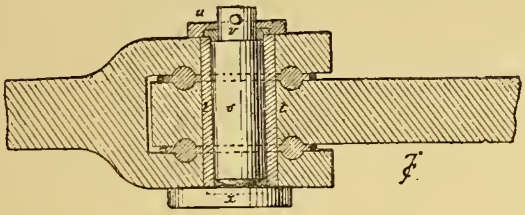
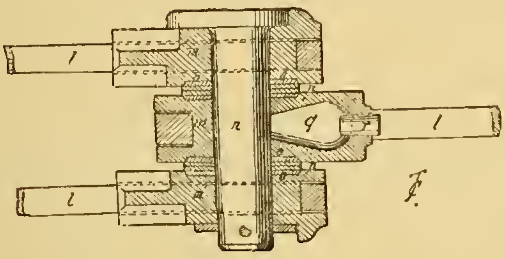
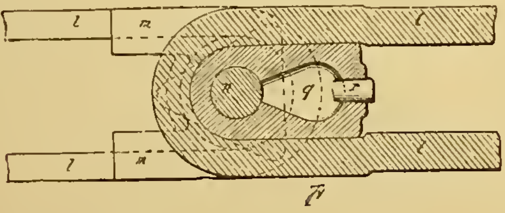


Fig. 3.



M. Couvreux has also introduced a number of other improvements in various parts of dredgers, among which we may mention one having for its object the diminishing of the wear to which the bolts connecting the links of the chain are liable, by reason of sand getting between the rubbing parts. Fig. 2 shows one method of obtaining this result.

Fig. 4.



The bolt, *s*, is surrounded by a steel hoop or ring, *t*, which may be readily renewed when worn out; and is retained in its place by a ring, *u*, and pin, *v*, passed through at the opposite end to that of the triangular head, *x*, the spaces into which the sand is liable to enter being filled with packing, retained in its place by iron wire.

Figs. 3 and 4 show another arrangement effecting the same object, in which the links, *l*, are formed of simple bars of iron curved to the form of elongated rings, into which is jointed a species of cast-iron head, *m*, perforated to receive the pin, *n*. The beads and links are put together in a very simple manner; the former are introduced into the link in a heated state, which is then slightly upset in the part situate between the two cast-iron heads, *m*. Recesses are provided in the thickness of the cast iron to receive caoutchouc washers, *o*, which maintain, pressed one against the other, steel washers, *p*, which prevent the ingress of sand. The central head of the link is also provided with a cavity, *q*, to contain oil for the purpose of lubrication, such cavity being stopped by a cork plug, *r*, as shown.

ON M. ADOLPHE MARTIN'S PROCESS FOR SILVERING GLASS FOR OPTICAL INSTRUMENTS AND EXPERIMENTS BY MEANS OF UNCRYSTALLIZABLE (INTERVERTI) SUGAR.[*]

Four solutions are to be prepared, which, being preserved in closed bottles, do not undergo alteration.

First, A solution of 40 grammes of crystallized nitrate of silver in a litre of distilled water.

Secondly, Pure ammonia diluted with water. The proper degree of concentration will be nearly obtained by diluting 70 cubic centimetres of pure ammonia of 24°[†] with 1 litre of water; it is, however, necessary to verify exactly the standard of the liquid; for that purpose 15 cubic centimetres of the solution No. 1 of nitrate of silver are taken, and into it is poured carefully the ammonia solution to be tried. At first a brown precipitate is produced, which afterwards clears up, and finally disappears as soon as a sufficient quantity of the ammonia has been added. If the liquor is of a proper standard, the quantity which will have to be added in order to obtain this limpidity will be exactly 10 cubic centimetres.

Thirdly, A solution of 40 grammes of pure caustic potash in one litre of water. The ammonia and the potash ought to be entirely free of carbonates.

Fourthly, 25 grammes of sugar are dissolved in 250 grammes of water; 3 grammes of ordinary nitric acid are added; ebullition is produced and maintained about during ten minutes, so as to effect the inversion change of the sugar, and it is left to cool; then, with the aid of a small quantity of the solution of potash (No. 3), it is almost entirely neutralized, so as to leave still a slight acidity: 50 cubic centimetres of alcohol are next added in order to prevent fermentation, which may set in later; and the whole is diluted with water, so as to produce the volume of half of a litre, if the silvering has to be done in the winter, or more, if the operation has to be executed in the summer.

Taking as an example of this silvering, that of a mirror or *speculum* of a diameter of 10 centimetres: upon the surface of the glass (which has been dusted with a camel's-hair brush) are poured a few drops of concentrated nitric acid, and with a plug of fine carded cotton, and perfectly clean, the glass is carefully wiped over, rinsed with water, and afterwards properly dried with a fine and clean linen cloth. A mixture of about equal volumes of the solution of potash (No. 3) and alcohol is then prepared, and is used for again cleaning the glass with a plug of cotton. This liquid, which is of a slightly sirupy consistence, has the peculiarity of not running off at the edges, as is the case with other liquids. The mirror, the face being covered with the liquid in this manner, is placed in a basin containing pure water; care must be taken that there is at least half a centimetre of depth between the glass and the bottom of the basin, which is secured by supporting the mirror by three small blocks of wood; the alkaline layer, which covers the upper surface of the glass, is then dissolved in the water by a slight undulation given to the basin. Into a glass of a proper size are successively poured:—

15	cubic centimetres	of the solution of nitrate of silver, No. 1.
15	" "	of d luted ammonia, No. 2.
15	" "	of the solution of potash, No. 3.
15	" "	of the liquid of inverted sugar, No. 4.

This mixture is put into a small basin (*assiette*), and the glass which has been in the water is rapidly transferred to it—the glass being again kept half a centimetre from the bottom, as was the case when immersed in the water—and it is continually and slightly agitated in the fluid. If the liquids have been well prepared, the solution of nitrate of silver, which had been made turbid by the first addition of ammonia, becomes again limpid, and the transparence of the mixture is not altered when the potash and the sugar are poured in afterwards. The final liquid must at the end of half a minute change to a yellowish rose colour, then to yellow brown, and then to ink-black. At this moment the silver commences to precipitate on the borders of the basin with the appearance of platina, and then a very regular coat of silver without clouding deposits on the glass; the agitation is continued from time to time, and when the liquid, which has become thick and grayish, gets covered with some brilliant scales of silver, the operation is finished. The mirror is then removed and carefully washed under a fine stream of water for a sufficiently long time, and afterwards with distilled water. The surface being washed pure, the edges are well dried by placing it on doubled sheets of blotting paper. When dry the surface appears brilliant, and its metallic lustre only covered with a slight veil, which may easily be removed by means of a plug of chamois leather with a little rouge powder. If the ammonia and the potash are free from carbonates, and the surface of the mirror has been well cleaned, the silvering is perfectly brilliant and polished under this veil, and there is no occasion to insist upon the rubbing with the plug.

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[*] The term *sucre interverti* has been given to cane sugar which has been acted on by acids, or certain other agents, whereby such a change in its molecular constitution and action upon light results, that whereas in cane sugar the transmitted ray of polarized light is caused to rotate to the right hand of the observer, in the latter the ray is caused to rotate to the left.

[†] The degrees are those of Beaumé, commonly used in France.

The following are the principal accidents which may happen in consequence of inaccurate volumetric preparation of the liquids. If the ammonia is too concentrated the final liquid remains limpid, and in becoming coloured it passes through violet tones; white light reflected from the surface of separation of the glass and of the liquid, and before the silver appears, is coloured violet. The silvering produced under those conditions is slow, very thin, dull and yellow by reason of thinness and transparency. When the ammonia is of a proper standard the reflected image of the plate has dark tones, and the silver plating is produced at the end of about five minutes, and gives a layer of a blue colour by transmitted light, and of a very brilliant metallic lustre by reflected light. Any insufficient cleaning of the glass produces greenish tones by reflection, with persistent cloudings. If the ammonia is too dilute the liquid gets turbid as soon as the potash is added; but none of these inconveniences happen if the mixtures above given are exactly followed. If there be much carbonate in the ammonia or in the potash, a white precipitate is produced which colours very rapidly when the sugar solution is poured in; the reducing action passes then sooner in the body of the liquid than upon the surface of the glass mirror. Even a minute trace of carbonate gives a matted surface on the silvering, and the leather plug and rouge fail to produce a good lustre. The degree of concentration of the solution of sugar is also of importance. If it is too weak the action is slow and incomplete; it is, however, easy to increase the dose even during the course of the process. If it is too strong the action is too rapid, and goes on mainly in the liquid itself, and is difficult to regulate. It is always advisable to make a preliminary essay, as the concentration of the reducing agent has to be in accordance with the external temperature of the air. The manner of operating thus described may be applied to all mirrors, the dimensions of which do not exceed 25 centimetres in diameter; but when larger pieces are to be dealt with a much slower way of operating is required; the liquid may withdraw from the edges of the glass in passing it from the water to the silver bath, and that produces spots of matted and dull silver. This bath may thus have time to get some floating particles of reduced silver, which cause small holes in the coat of silver. This is particularly injurious when found upon a mirror destined for the observation of the sun, as it was employed by M. Léon Foucault. In these large examples the operation must advance in a regular manner, and with a certain slowness. We must adopt the preparation of a liquid the volumetric standard of which is a little more difficult to obtain, but which answers perfectly the intended object. The following is the working method employed in these cases by M. Foucault; the method differs from the one above given only in the manner in which the water is proportioned in the solutions, and in introducing the silver into the liquid only at the last moment, and that it is which chiefly is of advantage.

A first solution is made of—

Caustic soda, ...	6 grammes.
Ammonia at 20°, ...	12 cubic centimetres.
Water, ...	800 " "

A second one of—

Nitrate of silver, ...	14 grammes.
Water, ...	100 cubic centimetres.
Ammonia at 20° . . .	20 " "

And finally a third solution of—

Sugar, ...	4 grammes.
Water, ...	50 cubic centimetres.

The sugar is inverted and neutralized just as before. The surface of the glass, after being well cleaned, is covered with a mixture of equal volumes of syrup, of sugar, and of water* (a plug of cotton surrounded with a piece of fine linen is used for the purpose of spreading it), and the glass is then immersed with the same precautions as precede, in a basin of porcelain, of silvered copper, or of gutta percha, according to the required dimensions. The solution of ammonial soda has been put into this basin. The glass is supported by blocks which allow below of it the largest possible depth of liquid; we agitate gently as before, and at the end of a quarter of an hour the second and third solutions, which are only then and at the moment mixed, are added. The proportion of the sugar varies with the temperature, and a preparatory experiment will prove that the quantity be suitable, if the final mixed solution shows a rose brown colour after a time which should vary between three and five minutes.

Demi-silvering.—M. Léon Foucault has finally, for certain experiments, suggested the application of what he calls *demi-silvering.* He employed for this his old process, but it is very easily obtained with the one of the two above given; it is only necessary to stop the operation at the moment when the silver commences to appear upon the glass. This is then withdrawn from the bath, well washed with distilled water, and dried; the polishing plug must here, however, not be applied. The layer of silvering is about twice as transparent as if it had been fully silvered over, but the reflecting power of the glass has become already great enough for optical purposes, so that the same glass can be used for observing at the same instant, and two different objects seen, the one by reflection, the other through the glass by transmission. This property offers great resources in the construction of many optical and astronomical instruments, and admits of many precious experimental applications.

IMPROVED SLIDE REST.

THE annexed engravings, for which we are indebted to the *Propagation Industrielle*, represent an arrangement of self-acting slide rest, designed by the engineers of the Graffenstaden Works for the manufacture of augers, the object of which is to provide in the auger a certain amount of clearance, not only at the external part, but through the whole body of the thread, by which the cutting action is greatly facilitated, and friction is considerably diminished.

The main principle consists in imparting a to-and-fro motion to the tool during the rotatory motion of the article to be operated upon, such motion being produced by an excentric with a variable stroke, and by a train of gearing. The number of motions of the tool during one turn of the article may be determined at will, and they may be either continuous or intermittent; the proportion of speed of the advance or backward motion of the tool with the circular motion of the article may be varied by employing for the excentric motion wheels of a special form, say, for instance, oval wheels. The apparatus, which may be applied to any ordinary lathe, is very similar to the common slide rest. If the excentric be thrown out of action by placing it in the centre of the plate which carries it, the apparatus may be used to turn or bore cylinders or cones; but by actuating the excentric, and suitably adjusting the same, an oval or a species of rose form may be produced, some varieties of which will be most suitable for augers and other tools, winch handles, coupling boxes, &c. The turning of the conical parts is effected in the usual manner.

Fig. 1 is an elevation of the apparatus, shown applied to an ordinary screw-cutting lathe; fig. 2 is a transverse section taken through the centre of the slide rest; and fig. 3 is a detached view of the bearing of the change wheels. Various arrangements of change wheels may be employed to produce the required intermittence in the to-and-fro motion of the tool, and elliptical change wheels may also be used for the production of a variety of oval forms.

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* It is not quite clear here whether the author means cane sugar or interverted sugar; we presume, however, the latter.

The slide rest is composed of a piece, A, provided at its upper part, at right angles to the centre of the lathe, with a dove-tail recess for the reception of a couple of slides, B and C, the upper one, C, of which carries the apparatus for fixing the tool, as in ordinary slide rests. An excentric button, D, attached to a slide of the plate, F, which is fast on the shaft, G, imparts a to-and-fro motion to the slides, B, C, by being moved in the recess, E, formed in a piece which is firmly secured to the slide, and in which this button is capable of sliding freely. The distance from the excentric button to the centre of the plate, F, that is to say, its stroke, is regulated by a screw in the ordinary manner, and the button is fixed in position by a nut. The shaft, G, turns freely in a bearing, H, cast in one with the piece, A. As the position of the slide rest requires to be varied with respect to its distance from the centre of the lathe, according to the diameter of the articles to be turned, the piece, A, is rendered capable of traversing the length of a transverse groove formed in the lathe slide, in which groove the heads of the bolts, *a*, slide; the position of the piece when adjusted is maintained by tightening the nuts of those bolts. It is requisite that the shaft, G, which carries the excentric plate, F, should be rotated during its movement with the slide of the lathe. It passes through a bearing or socket, I. which turns freely in the socket of the slide bearing, J (figs. 1 and 3), and has a pinion, K, keyed on it, a nut, *b*, maintaining the pinion and bearing in place. The pinion, K, is in gear with the wheel, L, fixed on the face plate of the lathe, and receives its motion therefrom, which it transmits to the shaft, G; the latter being keyed to the bearing, I, and being provided with a slot for the traverse of the key, in order to admit of its longitudinal motion. A slot is also formed in the bearing, J, for the reception of two bolts, *c c*, which attach it to the puppet of the lathe, and facilitate its transverse adjustment to suit the position of the slide rest.

Fig. 1.

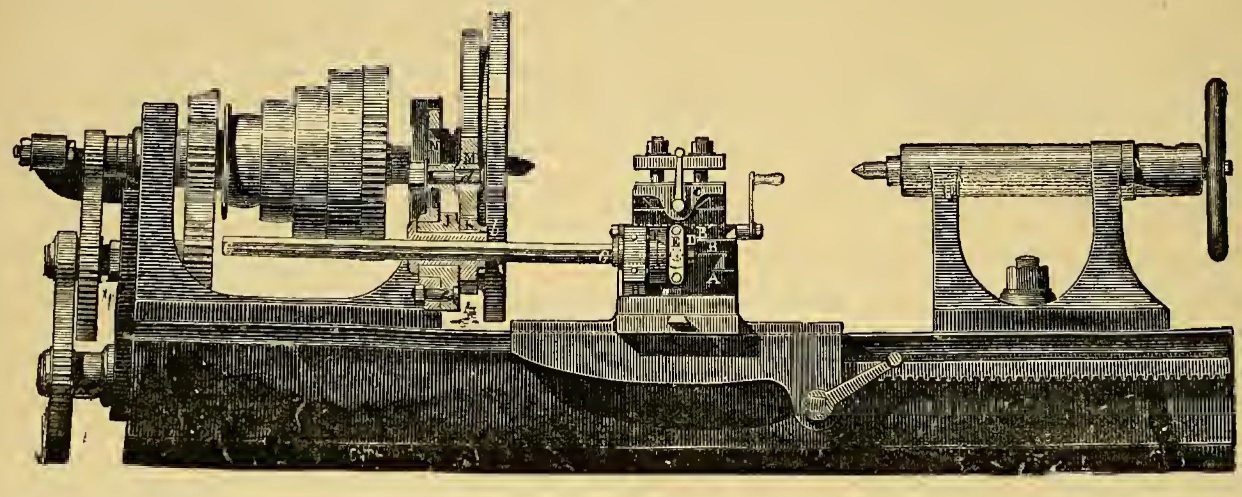
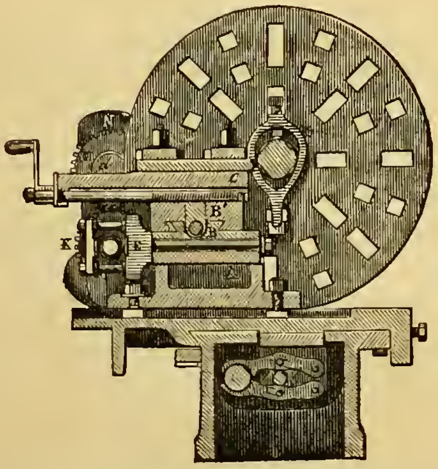
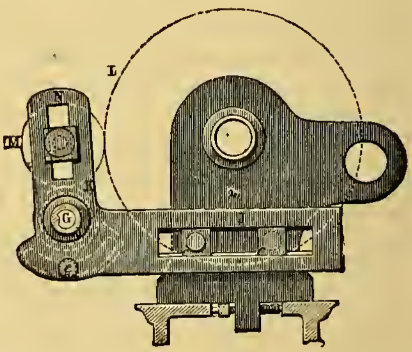


Fig. 2.



It may sometimes occur that in adjusting the position of the rest to certain kinds of work, the distance between the wheels, L and K, becomes so great as not to admit of their gearing together. In order to obviate this defect, an intermediate wheel, M, is provided, which turns freely on its axis, *d*, fixed on a support, N, such support having a slot formed in it for the purpose of adjusting the position of the wheel, M, to that of the wheels to be put in communication. The support, N, embraces the socket, J, so as to be capable of moving round it, and it is maintained in position by the bolt, *e*.

Fig. 3.



By suitably regulating the proportion between the wheels, L and K, a large variety of sectional forms may be produced, consisting of a diversification of bosses or projections. The form and extent of such projections or bosses may be varied by changing the stroke of the tool, which is represented by the maximum distance existing between the perimeter of the pieces turned and the circumference which inscribes them, whilst the number of the bosses is determined by the proportion between the wheels. Articles of these sections may also have a screw thread cut therein, and thus screw augers may be produced which will possess many advantages over those at present employed. By substituting oval wheels for the intermediate wheel, M, various elliptical forms are obtained, having any required number of bosses on their perimeter. It will thus be seen that, by suitably adjusting the gearing, a multiplicity of sectional forms may be produced applicable to a variety of useful purposes.

ROCK-CUTTING TOOLS AND MACHINERY.

(*Illustrated by Plate* 14.)

Mr. J. D. **Brunton**, who has for some time past given considerable attention to the subject of cutting and working stone, and to appliances for performing those operations, some of which have already appeared in our pages, has recently brought out some improved forms of cutters intended to be used in a species of slotting machine, for the purpose of separating or dividing slabs of stone, or for grooving the face of a rock *in situ*. These improvements form the subject-matter of our Plate engraving this month.

Figs. 1, 2, and 3 (Plate 14), represent one form of Mr Brunton's improved tool or chisel for cutting rock either *in situ* or when in detached slabs. This tool consists of a chisel the cutting edge of which is curvilinear, or, by preference, semicircular or of the nature of a gouge, bevelled towards the hollow or concave side and straight down the back or convex side. The bevel is carried upwards at the same angle from all points of the curved or semicircular edge. Those parts which otherwise form corners at each extremity of the curve or semicircle are rounded off and are brought to a cutting edge. The stem of the chisel is made just sufficiently narrow to afford clearance in the cut, but not more; the object being to retain all the strength possible. A guide is placed behind the chisel as described below, against which it slides when at work. This guide is made very rigid, and is attached firmly to the carriage—its object being to hold the tool to its work and to prevent its springing away from the cut. The tool or chisel is intended to chip or split off pieces from the rock; the form and mode of application being especially designed to effect this with the least possible attrition, and to make the action one of simple splitting by forcible pressure upon the edge of the tool.

Figs. 4, 5, and 6 represent another form of the improved tool, having two cutting edges. This form is intended for use in cutting slabs, and the stroke of the machine is to be so regulated as that each of the cutting edges, *a b*, will in turn operate from opposite surfaces as far as the middle or above the middle of the slab. The object of this arrangement is to avoid splitting off fragments from the under face of the slab, which the tool represented in figs. 1, 2, and 3, is liable to do if allowed to pass through the entire thickness of the slab.

Fig. 7 and 8 represent respectively a front and side elevation of the improved machine, by which, with either of the tools above described, the required grooves or slots may be cut in the rock or slab. This machine may be used to cut or subdivide detached slabs of rock, or it may be fixed upon the face of the rock itself, and be applied to cut it *in situ*. A is a fixed bed or base plate, B a slide with upright standard, C, and vertical guides, D, in which the tool-holder, E, moves; F G are winch handles, by which, in the case of cutting slabs, the machine may be worked by hand, or, if preferred, a belt may be placed on the periphery of the fly-wheel, H, conveying motion from a steam engine or other prime mover, or one of Fowler's clip pulleys may be substituted for the fly-wheel, and the machine may thus be actuated by a wire rope. I is a spur wheel fast on the shaft, I′, driven by the pinion, K, fast on the shaft, L; M is a crank pin on the face of the wheel, I, to which is attached the connecting rod, N, which communicates to the tool-holder, E, its reciprocating motion; O is the cutting tool, and P the rigid guide secured to the slide, B, by which this tool is held to its work; Q is a ratchet-wheel, worked by the pall, R, which is moved at each stroke of the machine by the cam, S, on the shaft, I′, acting against the roller, T, on the suspended arm, U. A shaft, V, passes through the ratchet-wheel, Q, provided with a longitudinal slot in which slides a key or feather fixed in such wheel, by which arrangement the shaft, V, is caused to revolve with the wheel, Q, at the same time that it is at liberty to slide through the wheel, whilst the slide, B, moves along the face of the bed, A. On the other end of the shaft, V, is the spur wheel, W, geared into the wheel, X. This wheel actuates the horizontal screw, Y, by which the slide, B, is caused to travel along the bed, A, and so feed the tool up to its work.

In the Plate engraving the fixed bed plate, A, is represented as being bolted down upon a detached slab, Z, by means of the bolts, *c c*, and the clamps, *d d*, but in the case of cutting *in situ*, the inventor prefers that the bed, A, should be fastened down by bolts passing through clamps or glands, which rest upon flanches cast on the inner side of the bed, A. The holes to receive these bolts would be made in the rock in the line of the intended slot.

In cases where atmospheric pressure may be advantageously employed as a means of holding down the bed, Mr. Brunton proposes to form the lower edge or base of the bed with one or more recesses extending along its whole length, and by means of an air-pump to produce a partial vacuum in the recesses, an air-tight junction being established between the bed and the surface of the slab or rock by means of india-rubber packing.

There is a saying as to the merit of "making two blades of grass grow where only one grew before," and it may be regarded possibly as equally meritorious to be instrumental in producing two tons of marketable slate where only one was produced before: especially when it is remembered that this marketable slate is reached, for the most part, only by a large outlay.

For the information of those who are unacquainted with slate quarrying, it may be well to state that out of a bed of good pure slate about four-fifths is broken and spoiled in the getting, and only about one-fifth finds its way to the market; and that, as this four-fifths must all be quarried and removed, the expense incurred in respect of it has to be borne by the one-fifth. Let the one-fifth be made two-fifths, and we have not only doubled the produce but we have reduced the unprofitable expenditure by 25 per cent. also.

Such an improvement, or something like it, is anticipated from the use of the machine, one form of which is presented in the accompanying engraving.

It is designed to cut the slate *in situ* across the cleavage, and thus to permit of its being freed by wedges or feeble blasts without shattering.

Another application proposed is to cross-cut long slabs after they are disengaged from the quarry, instead of breaking them across, as at present practised.

A bed of slate, under existing methods of quarrying, is in a condition somewhat similar to a plank in the hands of a carpenter, who, for want of a saw, has to break it.

The machine will be very shortly in operation, and the results shall be communicated to the readers of the *Practical Mechanics' Journal* in due time.

MECHANIC'S LIBRARY.

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Zeuner's Treatise on Valve Gear. By Müller. 8vo, 12s., cloth.

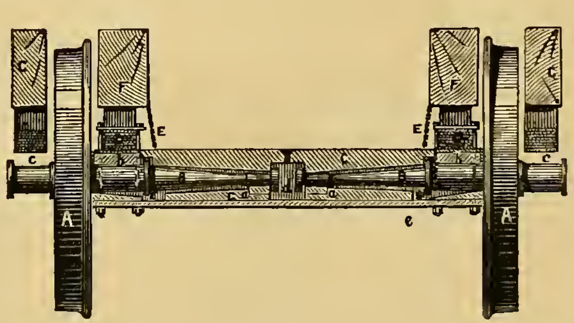
RECENT PATENTS.

RAILWAY ROLLING STOCK.

Henry Chaytor.—*Patent dated 27th April*, 1868.

This invention has for its object the facilitating the passage of rolling stock along railways, tramways, and rolley-ways, by enabling the wheels to run round independently of each other, in lieu of securing two wheels on to the same axle as heretofore.

The accompanying engraving represents a sectional elevation of a pair of wheels mounted independently of each other, in accordance with the invention. Each wheel, A, is secured to an independent axle, B, which extends about half-way across the framing of the vehicle, meeting the corresponding axle of the opposite wheel in the same axial line (or each axle may be placed in a separate box). These axles are tapered to their inner ends, and inclosed in a box, C, common to both, and have each a bearing, *a*, at their inner ends in the said box, and another bearing, *b*, next the wheel, also placed in the box, C. Above the latter bearing the chief sustaining springs, D, of the vehicle are placed, resting upon the box, C. This box is made in two or more pieces longitudinally of any suitable metal, or combination of metals, whether cast or rolled, bolted together. Should there be any rolling tendency (which is not expected), there are attached short check chains, E, fastened



one to each end of the said box, C, and attached to the inner frame, F, of the vehicle, as a precaution, immediately above which chains may be adjusted by screws, and so check the least tendency to rolling. The bearings in the said box, C, are to be lubricated with oil. When oil is used, it is supplied from a small reservoir or well, *d*, in the box by the rotation of the axles themselves, and which, after oiling the central bearings, flows along the axle-box into wells, *e*, adjoining the bearings, *b*, next the wheels, which bearings may be oiled in a similar manner to the bearings, *d*. The box, C, is to be furnished with covered apertures, by which to inspect the bearings at any time when requisite. The original outer frames, G, may be retained in combination with the inner frames, F, if desired, by extension of the axle; but such is unnecessary and undesirable.

PACKING BOTTLES.

John Perry.—*Patent dated 6th April*, 1868.

This invention relates to a peculiar mode of packing bottles, jars, and similar articles, and in the construction and arrangement of cases or holders therefor, whereby bottles so packed are not only protected from accidental breakage during transport, but a given number may be packed in a much smaller compass than heretofore.

According to this invention it is proposed to fit into a box or packing case a number of light tubes, which may be composed of tinned iron-plate or other sheet metal, or of paper, cardboard, or other suitable material of convenient height and diameter, according to the dimensions of the bottles to be packed, each bottle being intended to be dropped into its own tube. The several tubes, which may be either loose or fastened together, are so arranged that the tubes in one row break joint with those of the adjoining row, in lieu of each tube being exactly opposite its neighbour, whereby a saving of space is effected, and the entire area of the box or case with very little loss is subdivided into a number of cylindrical cells, somewhat like a honey-comb, for the reception of the individual bottles. One layer of tubes, say two dozen for example, is sometimes placed horizontally in the bottom of a case, and in front of this set of tubes is introduced another set or row of two dozen tubes, the several tubes in each set being held or fastened together in any convenient manner or left loose as preferred. Between the two opposite sets of tubes there is sometimes introduced a sheet of metal so perforated as to take the necks of all the bottles in both sets of tubes, the necks being made to face each other and to fit "neck and neck" without the possibility of touching each other. The system of tubes may be adapted to wine cellars or stationary receptacles for botles, as well as to packing cases for transport.

Fig. 1.

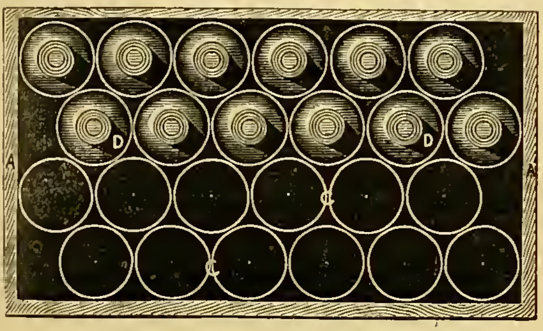
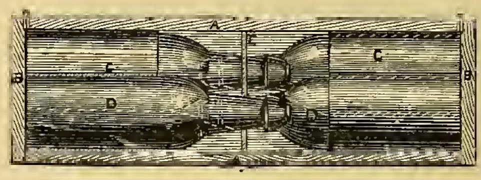


Fig. 1 of the engravings represents a sectional plan of a packing case fitted with a series of upright tubes according to the arrangement herein first described. A, is a wooden or other packing case provided with a hinged or other lid or cover, and having a number of tubes, C C, composed of tinned plate or other thin sheet metal, or of paper, cardboard, canvas, or other light and thin material suited for the purpose. These tubes are disposed in rows, but the tubes in one row break joint with those in the adjoining rows; that is to say, they are placed opposite to the divisions between the tubes in such adjoining rows, whereby space is saved. It is immaterial whether these tubes be secured together and to the case or not, as they may be left loose if desired. Each tube should be sufficiently high to inclose the main part or body of the bottle, D, or other like receptacle placed therein, and should be of such a diameter as to enable the bottle to fit easily therein without undue shaking.

Fig. 2 represents a transverse vertical section of another arrangement of the tubes, and fig. 3 is a corresponding sectional plan of the same: A is the packing case, and B B are two hinged lids opening at the sides of the case in lieu of at the top. Inside this case are disposed one or more rows of tubes, C, similar to those before referred to, but laid horizontally and so as to leave a space between the adjoining ends of each row for the reception of the necks of the bottles, D, which are to be inserted into and withdrawn from their separate tubes at the front or back of the case as required. E is a vertical or other partition extending from end to end of the case, and having holes made therein for the reception of the bottle-necks of both rows of bottles, as shown clearly in fig. 3, the tubes in one row being made to break joint with those of the opposite row, in order that the bottles may lie neck and neck, and so economize space. If desired, this partition may be dispensed with, and it may, like the tubes C, be either loose or fixed into the case. The bottom of the case may either contain two rows or sets of tubes, disposed end to end, or one or more other series similarly arranged may be disposed on the top of the bottom series. Moreover, in lieu of two rows of tubes being placed in the same horizontal plane as in fig. 3, one row only may be disposed on the bottom of the case, and other rows placed thereon horizontally so as to break joint with those below. In this case one door only will be required.

Fig. 2.



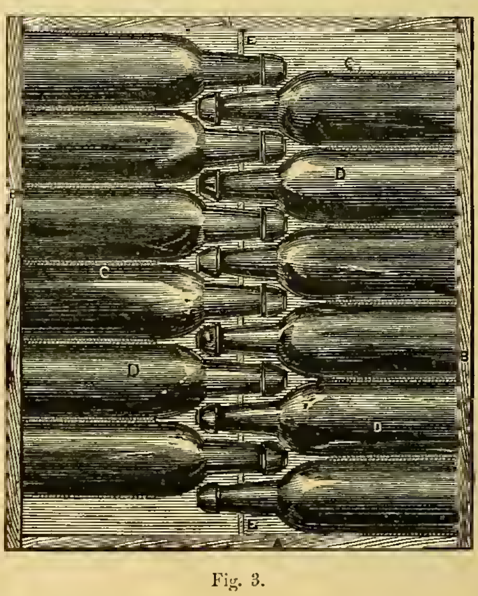


Fig. 3.

Although the invention is here described as applied only to transportable cases or holders for bottles, it is obviously equally applicable to stationary or fixed bins in wine and beer cellars or other stores.

CLEANING ROADS AND STREETS.

W. J. Trueman, *Belfast.—Patent dated 19th March*, 1868.

This invention relates to an improved arrangement and combination of apparatus intended to be worked by horse, steam, or other power, for the collection and removal of mud and other accumulations from the surface of roads and streets. According to one form or arrangement of machine a mud cart is combined with a mud-collecting and removing apparatus; the said two parts of the machine being each mounted on running wheels of its own. The mud-cart, which forms the leading or fore part of the machine, is provided with a covered receptacle, into which the mud is discharged from an adjustable spout, or shoot, carried by the hinder portion of the machine. One of the wheels of this part of the machine has a series of buckets or elevators formed in its rim, into which the mud is scraped by a scraper or brush, set at an angle or otherwise to the track of the machine, so that as the whole progresses the mud will be gradually collected to one side of the track and forced into the elevating buckets in the lifting wheel, which discharges it into the inclined shoot, or spout, above referred to. If desired, a special brush may be employed in lieu of a scraper, this brush being rotated from the machine itself in such a direction as to drive the mud and other accumulations into the elevating buckets of the lifting wheel. According to another modification, it is preferred to dispense entirely with the mud cart in front, and substitute for the inclined shoot or spout above referred to, a mud receptacle, into which the lifting wheel discharges direct. This receptacle is to be emptied when full into the ordinary scavengers' carts, or other receivers. A snow plough is provided for use in heavy falls of snow, and a heating apparatus applied in order to keep the tank or receptacle at a sufficiently elevated temperature to melt the snow, which is allowed to run off by an overflow pipe.

Fig. 1 of the engravings represents a side elevation of one arrangement of the improved apparatus for collecting and removing mud and other accumulations from the surface of roads and streets, the near running wheel being removed to show the parts more clearly; and fig. 2 is a plan of the same, with the adjustable spout and mud cart removed. *a* is the axle of the machine, to one end of which is secured a lifting wheel, *b*, whilst the opposite end of the said axle carries the running wheel, *c* (fig. 2). The lifting wheel is provided at its rim with a number of pockets or buckets formed by the angular partitions, *d d*, the open mouths of such buckets being on the inner side or face of the rim; *e* is a scraper placed at an angle to the line of draught, so that as fast as the mud is scraped from the surface it is impelled or moved laterally towards the open mouths of the buckets in the lifter, *b*, and enters the lower buckets of the said lifter as fast as they are brought round by the onward progress of the machine.

Fig. 1.

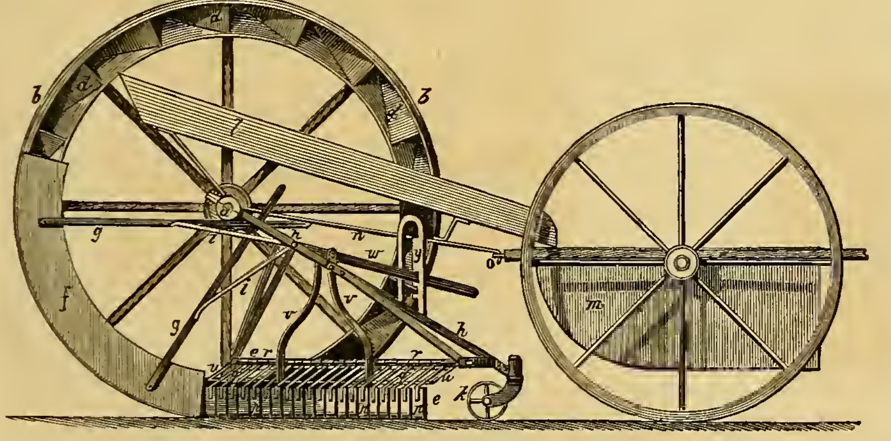
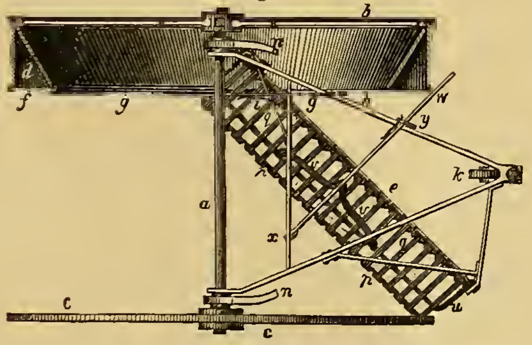


Fig. 2.



In order to prevent the mud from escaping again from the lifter a guard plate, *f*, is applied to the inner side of the rim, such guard extending from near the bottom of the lifting wheel above the centre or axis. This guard plate is supported by the bars, *g*, *g*, which are provided with slots to regulate their position, and are connected to the scraper frame, *h*, by a bolt passing through the slots and through the said frame. *i*, *i*, are blade springs secured to the scraper frame, and pressing against the bars, *g*, in order to hold the guard plate against the wheel. The scraper frame is connected at its upper end to the axle, *a*, whilst its lower end is supported by a small swivel wheel, *k*. The mud having been thus introduced into, and retained within the buckets, is carried up by the revolution of the lifting wheel until the buckets by their inclination discharge their contents into a spout or shoot, *l*, which directs the mud into any convenient mud cart, *m*, to which the scraping machine is connected by the hauling frame, *n n*, attached to the axle, *a*, and attached in the most convenient way to the rear of the mud cart at *o*, as shown clearly in fig. 1. The scraper may be of any suitable construction, but it is preferred to construct it as shown in the engraving; that is to say, of a number of separate narrow scrapers, *p*, one of which is shown in enlarged detail, elevation, and plan, at fig. 3, the edges being chamfered to prevent clogging as much as possible. Each scraper is attached to an arm, *q*, which is bolted to a hinge piece, *r*, on the carrying rod, *s*. Beneath each of these arms, *q*, is attached a blade spring, *t*, fastened between the arm, *q*, and the hinge piece, *r*, the free ends of the several springs passing underneath the horizontal rod or lifting bar, *u*, which extends along the underside of the whole of the scraper arms, *q*; such rod serving the two-fold purpose of lifting the scrapers clear of the ground, and regulating their pressure thereon, as it forms when in its lowest position the fixed bearing point for the several blade springs, *t*. The lifting bar, *u*, is connected by links, *v*, *v*, to the regulating lever, *w*, which works on a fulcrum at *x* in the scraper frame, *h*, and may be fixed at any height by being engaged into one or other of the notches made in the slotted guide, *y*, a spring on the side of the lever serving to force it into the notches, and retain it therein. Each of the narrow pieces, *p*, of the scraper works independently, rising and falling to suit the inequalities in the surface of the road or street. By elevating the lever handle, *w*, the rod or bar, *u*, will be also elevated, and the scrapers will be lifted clear of the ground. On depressing the said lever the rod or bar, *u*, will be depressed forcibly against the springs, *t*, thereby holding the scrapers down upon the surface of the road or street.

Fig. 3.

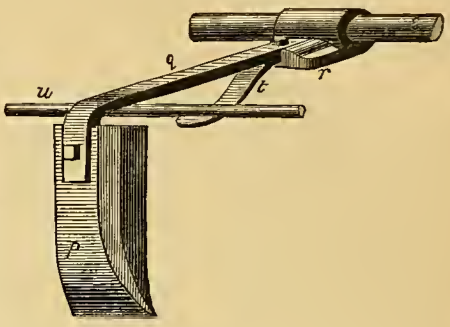


Fig. 4.

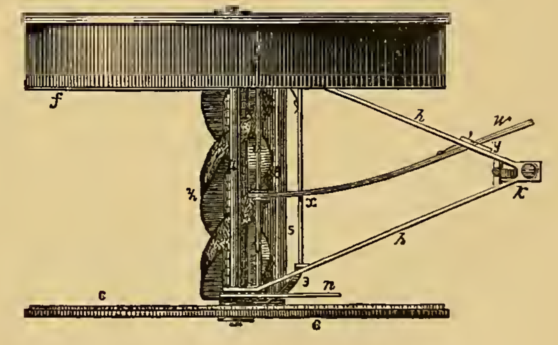


Fig. 4 represents a side elevation of a machine fitted with a revolving brush, in lieu of with a scraper (the near running wheel being removed). In this arrangement a mud tank or receptacle is fitted on the machine itself, in place of having the machine hooked on to the tail of a mud cart, as in fig. 1.

SIZEING OR DRESSING YARNS OR FABRICS.

John M'Kean, *of Walmer Bridge, Lancaster; and* John Stenhouse, *of Middlesex.—Patent dated 29th April*, 1868.

This invention has for its object the preparation of various novel compounds to be employed in sizeing or dressing and preparing yarns or textile fabrics. In carrying out the invention, "China clay" pipe clay, or other similar clays, are taken, and thereto is added the requisite quantity of starch, or amylaceous or farinaceous matters obtained from wheat, rice, potatoes, horse-chestnuts, sago, tapioca, salep, or any other convenient source. Previously to mixing them with the clay, the whole or a portion of the starch or amylaceous matter they contain is usually converted into dextrine or "British gum." This is effected by any of the known methods, such as heating them with dilute sulphuric, hydrochloric, nitric, acetic, or other suitable acids, or mixtures of any of them, or by heating them alone to a temperature of about 300° Fahrenheit.

Sometimes gum arabic, gum senegal, or similar gums, or the vegetable mucilage obtained from linseed, hempseed, or other known sources, are employed. If the above mixture be at all acid, a sufficient quantity of slaked lime in powder, or carbonate of soda, may be added to neutralize the acid. To this mixture is then added, by preference, sulphite of lime, or sulphites of baryta, magnesia, potassa, or soda, or mixtures of any of them, and subsequently a small quantity of tallow, or other neutral fat or oil. The "China clay" in the above-described compound may be replaced either by powdered gypsum, or other suitable form of sulphate of lime, or with carbonate of lime in a pulverulent state, such as whiting or powdered chalk. Mixtures of "China clay," gypsum, and whiting, together with sulphites of lime, baryta, magnesia, potassa, and soda, and the requisite quantity of starch, amylaceous matter, dextrine, or gum, and tallow, or fats, may also be employed.

The materials above described may be employed in various proportions, but a very useful combination may be formed by taking—

"China clay," kaolin, or other similar silicious or aluminous earths, ...	9 parts by weight.
Sulphite of lime, ...	1 part "
Starch, or amylaceous matter, previously converted into "British gum" or dextrine, ...	5 parts "

Another useful combination consists of—

"China clay," kaolin, or other similar silicious or aluminous earths, ...	8 parts by weight.
Sulphite of lime, ...	2 parts "
Starch, or amylaceous matter, previously converted into "British gum" or dextrine, ...	7 parts "

To both of the above compounds from 5 to 10 per cent. of fat should afterwards be added.

The patentees do not, however, confine themselves to the above proportions, but vary them according to the nature of the materials to be operated upon.

The composition or mixture resulting from the process above described is a perfectly dry and fine flour or powder, which requires simply to be mixed with water and boiled, in order to convert it into a paste of suitable consistency for use.

One of the great advantages in the above-described sizes consists in their containing quantities of sulphite of lime, or the other sulphites above mentioned, which, from their antiseptic properties, render the cloth and yarn to which they have been applied much less liable to be attacked by mildew, or to become tender or rotten, than is the case when they are sized in the usual manner.

LAW REPORT.

Craig *v.* M'Farlane.—A case of interest to paper-makers was recently decided by the Solicitor-General, Sir John Coleridge.

Mr. John M'Farlane, Leith Walk, Edinburgh, wire-cloth manufacturer, in the month of August last, applied for letters-patent for "Improvements in Rollers for Paper-Making Machines," and obtained the usual provisional protection on application. The application was opposed by Mr. Robert Craig, of Newbattle Mills, Dalkeith, on the ground that he was the first inventor of an under press-roller, covered with vulcanite and vulcanized india rubber, which formed part of Mr. M'Farlane's claim for a patent, for which Mr. Craig had also applied and obtained the usual protection. Parties were heard in accordance with the practice of the Law Officers, in the absence of each other. Mr. Grove, Q.C., and Mr. Junner, first appeared for Mr. Craig, and contended that he was the first inventor and applier of the roller, which had worked satisfactorily at one of his mills; that Mr. M'Farlane, who had obtained the material for the covering of the rollers from the North British Rubber Company, simply acted as Mr. Craig's employé, and had not the merit of the invention; and that Mr. M'Farlane had only applied for his patent after the rollers had been experimented with by Mr. Craig, and had been found a success. In answer to certain declarations filed by Mr. M'Farlane, in proof of his having experimented at a paper-mill at Wandsworth, in Surrey, counsel submitted that such experiments, assuming them to have been successful, had only reference to the under coutch-roll of the machine, and that Mr. M'Farlane, upon his own evidence, had not proved that he had ever experimented on the under press-roll, and was not entitled to the sealing of his patent.

Mr. Spence appeared for Mr. M'Farlane, and contended that he was entitled to the patent for the coutch and press rolls, and read certain declarations filed for Mr. M'Farlane. Mr. Craig's counsel having been called in, the Solicitor-General stated that he would cause Mr. M'Farlane's patent to be sealed for the coutch-roll alone, and would cause Mr. Craig's patent to be sealed for the press-roll, being all that was claimed by the latter in his specification.

REVIEWS OF NEW BOOKS.

The Lathe and its Uses, or Instruction in the Art of Turning Wood and Metal. (Anonymous.) 1 vol. 8vo. London: Trübner & Co. 1868.

A Treatise on Lathes and Turning. By W. H. Northcott. 1 vol. 8vo. Illustrated. London: Longman. 1868.

There is no need to say much more of the second-named work than that it is a plainly written, unpretending, and practical introduction to the use of the lathe, and instruction as to what may be done with it or by it, directly or indirectly. It deals not in the history or past phases of the turner's art, but with the actualities of the present day; and is illustrated, amongst other plates, with some views of lathes, &c., produced from photographs furnished by some of the very best makers, such as Fairbairn, Kennedy, and Naylor, of Leeds, &c. This would be a good book to put into the hands of a lad commencing his apprenticeship in a tool-making or engineering shop. The first-named volume is a still better—more exhaustive, and, we may say, a more scientifically written work, and better fitted for the advanced student of mechanical engineering. The author, who is probably an American, curiously enough thinks proper to conceal his name—he admits in his preface that a considerable proportion of his work consists in compilation from American journals; it may not be a bit the worse for this, however.

There are two appendices; one on the angles of tools, by Mr. Dodsworth Haydon, of Guildford; the other on a new arrangement of lathe and chuck to do rose engine work, by Elias Taylor, of Brighton. These, both by English authors apparently, are well written, and the latter is useful to the ornamental turner.

As to fine-spun theoretic dicta for fixing the angles of tools for various sorts of work, we confess we have not much respect for them, notwithstanding the names of Willis and Babbage, Holtzapffel, &c., with which such refinements have been connected. All of practical value on the subject of these angles can be stated in a few sentences, and becomes insensibly learnt by tact very soon by everybody. A razor, a wood knife, a wood chisel, a chipper for iron, a turning tool or drill, need different angles of edge; but we know so little of the nature of the resistance to division opposed by solids, or of the arrangements of their constituent molecules, that theory really decides little or nothing worth knowing as to the *limits* of best angle for various materials and different conditions.

The fact is, a turning tool, for example, will cut nearly any metal in the lathe at many angles of edge between 60° and 90°, and by varying speed and other conditions of application of the tool, and holding the latter with mechanical firmness, the same results may be obtained with larger variations of angle. For finishing *soft* brass the doctors fix the angle as 90°—*i.e.*, a square scraping tool; but for turning *hard* steel or chilled cast iron the same, 90°, is not only the best but the only angle that will stand long. Where is the *principle* that gets at these extremes? The fact is, much as has been written—prattled, we are almost tempted to say—by theoretic amateurs on this subject, the very fundamental basis for any sound theory upon it remains to be discovered.

The Transactions of the Society of Engineers for 1867. 1 vol. 8vo., with many Plates. London: Spon. 1868.

This, the last volume of transactions of this thriving young society' quite maintains the character of its predecessors, and something more, as several of the papers are less of a mere elementary character—having just a little of the smack of schoolboy exercise about them, as was the case with a few of the former ones—and two or three are really able and exhaustive. This is especially true of Mr. Baldwin's paper on "Safety Valves," Mr. V. Pendred's on "Tube Boilers," and, above all, Mr. S. W. Worssam on "Mechanical Saws," or saw mills in common language. Mr. A. Rigg, junior's, paper on "The Connection between the Shape of Heavy Guns and their Durability" does not add to what was previously known, as it appears to us; Mr Gresham's on "The most recent Improvements on the Injector," on the contrary, certainly does so, as it describes some modifications which, though exhibited at Paris in 1867, were not then anywhere fully described.

The volume, like all of the series, is got up in excellent style by the publisher: no clearer or better illustrations need be sought than the lithographs, which equal above a third of the volume in bulk.

A Practical Treatise on Metallurgy. By William Crookes, F.R.S., and Ernst Röhrig, Ph.D., in 2 vols. Vol. I. 8vo. Longman.

Mitchell's Manual of Practical Assaying. Edited by William Crookes, F.R.S. 1 vol. 8vo. Longman. 1868.

When the four volumes, or possibly five, of which these two works taken together will consist when the first-named of them shall be completed—and all be in the reader's hands—the best and completest system of assaying and of metallurgy proper, *i.e.*, manufacturing metallurgy, that has ever existed in English will be at the disposal of the reader of English only. In saying this we do not intend to disparage in any way some other works on metallurgy that exist in English, such as Truran's on iron, and more recently and notably Dr. Percy's two volumes which have embraced the metals copper, zinc, and iron. We refer here primarily to the fact that all anterior works are either incomplete, apply to very few of the important metals, or are, like Truran's, mere monographs. Mitchell's work on practical assaying has here reached its third edition, so that its reputation was already established before it became improved and enriched under the hands of Mr. Crookes and Dr. Röhrig. This rapid progress to a third edition proves at once the value of the work and the want that existed for it. The truth is there was, previous to the publication of the first edition, no useful English work on general assaying posterior to the date of the translation of Cramer's "Art of Assaying or of Docimacy"—now a century old or thereabouts. All other English works on the subject dealt with limited parts of it, chiefly those relative to the precious metals. Berthier's "Essais par le Voie Seche" has hence been almost the guide of British assayers for twenty years past; and although a noble product of clear, intelligent, wide-spread, accurate knowledge as it then was and is, it is far from forming a good or satisfactory book of reference to lay beside the assayer's hand upon the laboratory desk. This is so, not only from the nature and design of the work, and from the perfect *πληρωμα* of information with which Berthier's mind was encumbered we may say, but from the petty and yet, to many, effective drawbacks of the want of any good index to the two volumes, and even nowadays still, after our fifty-four years of peace, to the want of familiarity with the French language, so common a result of our national isolation, and far more of our defective system of education in England.

Well, these wants are now supplied, and they are so in this best of ways, that assaying is kept apart and by itself, as it ought to be, and not treated of along with metallurgy as though it were only a sort of stepping-stone to the latter. Metallurgy cannot get on without assays and assayers, but yet it may be practised—nay, all real, all practical (that is manufacturing) metallurgy, is actually practised through vicarious assaying—and by men having none of that experimental dexterity and knowledge which long experience in assaying can alone give, and which makes assaying in reality an *art* based on chemistry rather than a proper branch of science. Metallurgy, so far as it has any clearly definable meaning, is the systematization of those trains of processes by which the ends of manufacturing industry are met in the production of reguline metals from their ores. It, too, is really an art, or rather a constellation of arts, all based on chemistry and physics; and every attempt to treat it otherwise—to elaborate a science of metallurgy—has only resulted in the production of a more or less distorted system of inorganic chemistry. This even was the failure in Berthier's own hands, who endeavoured to stick closely to chemistry and to the description and explication of the practical methods of smelting, &c., that chemistry had taught. How much more must it be a ground of failure in works in which mechanical operations upon the brute metals (like rolling, forging, wire drawing) and mercantile considerations are also mixed up with the preceding matters, and with the fragmentary science on which they depend.

This grand line of boundary in metallurgy was clearly discerned by Professor Kerl in the great original work in German, in four massive volumes, of which we have here the goodly commencement of an English version; and we are certain that nowhere more than in England, where, unhappily, practice is so much more worshipped than theory, will the importance of having a work confined to manufacturing metallurgy put within reach be well appreciated.

The first volume comprises the smelting or other operations for the purpose of obtaining in the metallic state, under conditions for commerce, the metals, lead, silver, zinc, cadmium, tin, mercury, bismuth, antimony, nickel, arsenic, gold, platinum, and, in somewhat odd company, sulphur. The next is to contain the two most valuable of metals, as respects utility and wide-spread production—copper and iron.

We have examined the work with some care, and even compared one or two of its most important sections—viz., those on lead, silver, and zinc—with the most recent and authoritative information published on the Continent upon the metallurgy of those respective metals, and we are enabled to say that we have found very little, indeed, that need or could be added to make more complete the treatment of the several subjects.

Kerl's name and reputation—long famous in Germany, especially in Eastern Germany and in Prussia (he is now a royal professor at Berlin)—were alone enough to warrant this translation, but Messrs. Crookes and Röhrig have not been mere transcribers into English. They have taken discretion to omit statistic and other tables and matter, not of world-wide interest, here and there from Kerl's volumes, and have interpolated from their own pens much more than an equivalent of newer or more important information derived from their own or from other good sources.

Thus, under silver, the Pattinson lead-refining process has been treated in a very complete way, and brought up to the day. We are almost disposed to say, however, that justice has not quite been done to Mr Parkes' beautiful method of extracting silver from lead by alloying with zinc, and in this we are sustained by the authority of Professor Gruner of the Ecoles des Mines, in a recent report of his. We find, also, very full particulars of the methods of amalgamation by means of Mr. Crookes' own sodium amalgam, which, so far as our knowledge goes, are not to be found as fully given anywhere else.

The work assumes, as all such works ought to assume, that the reader is already a good chemist and physicist, which is only to admit that, if he be a smelter or the like, he has been properly educated for his business; and then, while it describes with all the needful exactness and detail, and with all necessary illustration (there are 207 woodcuts in the volume), the various processes, always holding in view that they are to be made *to pay*, that it is manufacturing metallurgy, *industry*, not laboratory experiment or speculation, &c., that are in view, it, when trying the merits and discussing the advantages or disadvantages of each method or operation, always does so by appeal to the bar of chemistry.

So the work is eminently practical and useful, and is so, in degree, just as the reader has his eyes opened beforehand by general chemistry and physics. We await anxiously the appearance of the second and subsequent volumes, of the second particularly, for an entirely recent metallurgy of iron does not at this moment exist in English. Mr. Bauerman's elegant little volume is rather a popular than a directive treatise; that is recent, but at the rate the metallurgy of iron and steel have lately moved, Dr. Percy's volume, published four years ago or so, begins to have *lacunæ*. No doubt Messrs. Crookes and Röhrig, even piloted by Kerl, will have a very arduous task to perform if they shall present a full, accurate, and detailed literary photograph of the last five or six years' improvements in the vast subject of siderotechny, and a true and practical picture of its present state. What they have done gives, however, good promise of what they can yet perform.—Ed.

Weale's Rudimentary Series. Virtue: London.

Brickmaking. By Dobson and Tomlinson, with additions by R. Mallet. Fourth Edition. Murray's Treatise on the Marine Engine. Fourth Edition. Questions on Magnetism, Electricity, and Practical Telegraphy. By W. M'Gregor. First Edition.

The first-named of these volumes was a good treatise on brickmaking before; it is now something better than it was, inasmuch as the additions made by Mr. Mallet have given to it what was not to be found in it, or any other work on the subject in English, a sketch of the science—*i.e.*, of the physics and chemistry of brickmaking. It is a mere sketch, however; much more might be written with advantage on that part of the subject.

The second treatise is that as to the publication of which the author, Mr. Murray, has so justly complained in the public papers. It was a good treatise for its time, probably, when first published, but needed much to bring up its leeway. This, the author complains, has been done or attempted by another hand, employed without his knowledge or sanction by the publishers, and whose work the author views as having by no means added to the value of his original. In that we are obliged to agree with the author. The book ought simply to have been reprinted as it stood, or all but rewritten, and not merely padded out by a bulky appendix, of which almost every page has been taken from easily accessible printed documents, &c.

We are sorry we cannot say anything in commendation of the electrical, &c., questions of Mr. M'Gregor. They remind us of the well-known saying of his own part of our island, "it is easier to speer than to answer." How knowledge is to be enhanced, or any smoother road into a man's head made for it, by a catechetical order, especially of questions without any answers, it passes us to comprehend.

Electricians are not supposed to be mere children; but whether children or sages, questions that admit of no definite answer and of one only, are mere puzzling traps—*e.g.*, question 55, Why should we avoid being near water during a thunderstorm? suggests amongst many other possible answers—No. 1, We are not aware that we *should* avoid it at all; No. 2, Perhaps we might be blown in and drowned; No. 3, We might be so circumstanced that near water would be the safest place we could be in, say in a steamboat at sea, with Harris' lightning conductors to the masts. Again, question 58, Are volcanic eruptions in the sea and tornadoes *in any way* connected with electricity? Now, who can give any direct or trenchant answer, except the man who is philosopher enough to say in reply, that so far as we know there is nothing in the universe that is not in any—*i.e.*, but *is* in some way, connected with electricity.

A Handybook for the Calculation of Strains in Girders and Similar Structures, &c. By William Humber, Ass. Inst. C.E., &c. 1 vol. small 8vo. London: Lochwood. 1868.

This *is* what it is entitled, a handybook, and it might be made in a second edition, to which we make little doubt it will in due course arrive, still handier, by printing in rather larger type, adopting a more absolutely uniform notation all through the volume, declaring the meaning of every symbol in the work at the beginning, and making a more liberal use of capitals in the formulæ, reserving these for one class of values or relations, and small letters for another, &c.

These and such like points being attended to, give that unequalled clearness to French and to some German mathematical works, which our English ones so often want. We remark this not as finding fault with the work before us, which is a good, clear, useful pocket or office reference volume for practical use, but as suggesting how we think hereafter it may be made still better.

It is very fully, clearly, and *cleanly* illustrated, the graphic methods of determining stress and strain are sufficiently shown, and it is *concise*, and we hope Mr. Humber may not be tempted, in any future edition, to deprive it of that cardinal virtue of all such works.

Atchley's Builders' Price Book for 1869.

The volume of this established work for the present year, which has become a trade tool in every architect's and builder's office, is the joint product of three authors, and the addition made by the last, Mr. Godfrey, solicitor, Gray's Inn, upon the law of strikes and combinations, is a valuable and timely one. The price lists profess to have been carefully revised throughout, and, beyond doubt, this work affords as much and as trustworthy information as any builders' price list can give.

Unfortunately in practice, as we have before now remarked, prices taken from such lists form very little real guide, either for employers or clients, as the politer phrase is, for architects, or for the trade.

When we find competitive tenders great and small, sent in for the same work, yet differing, between the highest and lowest, as much sometimes as in the ratio of two to one, it proves that other elements besides the value of "labour and materials," with which price lists deal, very generally go to determine what we have to pay for work done.

A Descriptive Treatise on Mathematical Instruments, their Construction, Uses, &c., with Hints on Drawing and Colouring, &c. By Wm. F. Stanley, Instrument-maker, London. Second edition, 1 vol., 8vo. Illustrated.

It is enough to say of this well-executed, clear, and concise little work, that it is the best treatise upon the whole range of instruments required for instrumental drawing with which we are acquainted in any language. The matter is the same as in the former edition, with some additions, such as follow:—Engraver's tray, p. 126; copying table, p. 127; set square for section lines, p. 159; description of planimeter, p. 207; gauge for cutting off drawings from the board, p. 217, and a few smaller descriptive paragraphs. It is infinitely beyond its earliest predecessor, "Adams on Mathematical Instruments," and has the good point kept clearly in view throughout, that it is not intended to teach drawing, nor yet the abstract principles upon which drawing or drawing instruments are based, but the use, choice, structure, and practices in reference to the instruments themselves. Though the book has an eye, and very justifiably, to trade purposes, Mr. Stanley being himself an instrument-maker of excellent repute, still so much genuine, practical information is in it quietly and tersely given, that we unreservedly recommend it to the careful study of every young engineer or educated mechanic. Without good drawing, men in these callings are like orators without tongues, and without good instruments good mechanical drawing is impracticable.

CORRESPONDENCE.

☞ We do not hold ourselves responsible for the views or statements of Correspondents.

(To the Editor of the Practical Mechanic's Journal.)

Sir,—In a review of the published parts of my work on "Steam, Air, and Gas Engines," which has appeared in your Journal, and to which my attention has been drawn, the following remark occurs:—

"In this Part I., too, are some autobiographic details, intended to show that Mr. Bourne was the first introducer of liquid fuel for raising steam by the use of coal-tar, which we happen to be in a position to prove are very essentially mis-stated."

Not being conscious of any mis-statement in what I have related in this or any other part of my work, you will perhaps have no objection to inform me in what the supposed mis-statement consists, so that, if I have unconsciously fallen into error, I may be able to correct it; and also, so that, if the misapprehension lies with you, an opportunity may be afforded for its rectification.

I am, Sir,
Your obedient servant,
J. BOURNE.

Leith, *February* 9, 1869.

In the passage above referred to of the review in question in our last Part, to which Mr. J. Bourne takes exception, nothing was impugned of the autobiographic details given by that gentleman, except in so far as they appear "intended to show that he was the first introducer of liquid fuel for raising steam by the use of coal-tar." The writer of the review in question is prepared to prove that that is not the fact; and further, that "the plan did not originate" either with Mr. Bourne or with Mr. J. O. N. Rutter, of Lymington; and, if Mr. Bourne insists upon it, the writer of the review is quite willing to publish these proofs.

Unless so compelled he is, however, unwilling to pursue the subject further, as necessarily involving the names of third parties, some of whom are now no more, and whose memories Mr. Bourne himself would no doubt desire to respect.

THE WRITER OF THE REVIEW.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL SOCIETY OF EDINBURGH.

THE following excellent paper, which has not yet appeared in print elsewhere, was read to the Royal Society of Edinburgh, February 1, 1869. In it will be found an elaborate consideration of many of the various arrangements and forms of governing mechanism introduced from the time of Watt (who first saw the necessity of some controlling mechanism for maintaining a constant speed of his steam engines) down to the present time. Professor Smyth gives the result of his researches, and the final embodiment of the instrument in a shape whereby it is rendered intensely sensitive. To our practical readers we would commend their careful perusal of chapter 5. As this issue of the *Practical Mechanic's Journal* concludes the annual volume, a great part of our space is curtailed through the insertion of the index; we hope, however, to remark on the matter hereafter.—V. D.

ON INTENSIFIED GRAVITY IN CENTRIFUGAL GOVERNORS.

By Professor C. PIAZZI SMYTH, F.R.S.S., L. and E., Astronomer-Royal for Scotland.

1. *Introduction.*—Having had occasion recently to improve the centrifugal governor of a small driving clock for communicating an equable movement to an equatorial telescope in the Royal Observatory, Edinburgh, I hope that some of the practical particulars may prove of service to many possessors of equatorials elsewhere, who, although furnished with some of the best apparatus of the day, and by leading opticians either of England or Germany, are yet often complaining of the inefficient performance of their clock movements. One special feature, too, of the apparatus which has just been composed will be found, I believe, though not absolutely new, yet far from widely known or extensively appreciated, notwithstanding that it promises as well for the ultimate perfection of the centrifugal governors of steam-engines as for those of uniform-motion clocks.

Now all the world knows, or has hitherto been taught, that the ordinary form of governor, or regulator of the speed, of a steam-engine, is a pair of that variety of pendulums called the conical or revolving pendulum, first applied to this purpose by the immortal James Watt; and it was also the first form of regulator utilized in this country by astronomers for equatorial clock-work motion; indeed it is often seen in that position still.[*]

Being then so extensively and variously employed, and having been in continued use ever since Watt's day, or approved by all the ages (of steam-engineering), some persons are even inclined, by means of a sort of moral rule of thumb method, to jump to the fixed conclusion that Watt's double conical pendulum is the best possible form of revolving centrifugal governor for producing equable rotatory motion both anywhere and everywhere; and that nothing better in practice—just as with gunpowder for shooting—need ever be expected, or will ever be discovered.

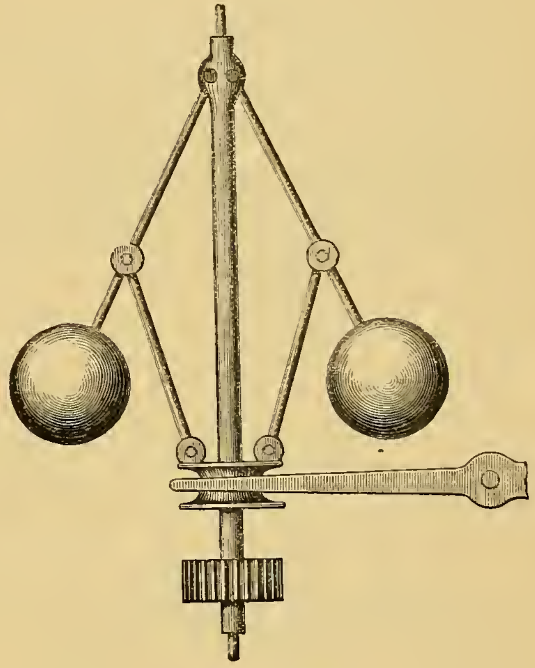
Yet this is certainly going a great deal too far; seeing that Watt's governor has been so often complained of as being too slow in its correcting influence, that Mr. Siemens was induced thereby to invent his beautiful and quicker system of differential wheels; and, while he applied them to steam-engines, the Astronomer-Royal (G. B. Airy) has introduced them under a variety of original and ingenious forms into the Greenwich equatorial clocks and chronographs. Much has also been written lately, and with immense learning, on the whole mathematical theory of centrifugal governors, often in very difficult shapes, by Mr Airy, Mr. Siemens, and Mr. Clerk Maxwell.

The general subject has thus been advancing theoretically in a remarkable manner; and yet, somehow or other, the ordinary practice of both engineers and opticians does not seem to have improved at an equal pace. Beautiful mechanisms, more complicated than those of old, have indeed been furnished by them, but with unequal success. And when many men in the astronomical world were recently beginning to think that their only hope of ultimate satisfaction lay in some still-to-be made, and more complicated, revolving invention of the future, behold them all thrown, only last year, into utter bewilderment on being told, and apparently on good authority, at the Royal Astronomical Society of London, that in any case where both great power and extreme accuracy of uniform motion are required, all forms, even the newest, of revolving or centrifugal governors must positively be thrown overboard, and recourse had to a mere old-fashioned *vibrating* pendulum—this being, of course, supplied with special means for rendering the movement continuous, if possible, on one train of wheels.[*]

No sooner, however, had this very notable rebuff in practice been given to divers of our best theorizers on, and employers of, *advanced* rotatory governors, than several persons in different parts of the country announced, and from independent lines of research, that they had found the oldest and simplest principles of the revolving pendulum, *when properly applied*, quite enough to produce all the accuracy required in any and every practical case that has yet transpired, even including that most difficult one of all, star spectrum observations.[†]

Now this latter conclusion was even more startling in its way than the former; and is perhaps only to be paralleled by what took place in the early railway world, when, after spending much time in devising the best forms of teeth for the wheels of locomotives and of racks for the rails, engineers suddenly found that neither teeth nor racks were required to insure the progression of a train.

But in the revolving-governor case now before us, we are not indeed told to go back to the very and actual Watt governor, as seen in nine hundred and ninety-nine out of every thousand British regulated steam-engines, but rather to its *principles* when *properly applied*. Let us ascertain, therefore, what practical refinements these weighty words, *principles properly applied*, may possibly here include.



James Watt's Governor.

2. *Recent Simplified Forms.*—Of the several very modern examples of *simplified* improvement just mentioned, I select for special attention one by Sir W. Thomson, of Glasgow, because not only has it been fully described and discussed only two months ago in the presence of, as well as printed and published by, the "Institution of Engineers and Shipbuilders in Scotland," but the practical men there present seemed, one and all, to listen almost with awe to the description of the accuracy which the instrument was capable of, and then to confess with full satisfaction, on seeing it perform, that it truly realized all that had been said for it.

This governor, though of a very original shape and unusual fitting, with broad spring suspensions and otherwise, was very modestly described by Sir W. Thomson as being "of a perfectly rudimentary type, and presenting no novelty except in some details as to arrangements and proportion of its parts."

In what then did its peculiar, or its admitted almost extraordinary, effectiveness consist or depend upon?

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[*] While the chronometric principle is the same when the conical pendulum is employed in clocks as well as steam-engines, it must be duly borne in mind that the principle is made to produce its *correction* in a totally different manner in either case. In clocks, where the motive power is always very small, the flying outwards of the pendulum bobs, when the revolution is too quick, is made to produce so much friction, somewhere or other, as in that way to consume totally all the overplus of power. But in steam-engines, where the overplus of force might be something excessive, a due regard to economy will not allow it to be wasted in that manner; and therefore the flying out of the balls is made there, not to produce friction, but to cut off the supply of steam to the engine until its rate of working is effectually moderated by starvation of its energy.

[*] The case here alluded to is that of the since deceased Thomas Cooke, the celebrated optician of York, and maker, in his time, of more revolving equatorial clocks than perhaps any other man; and yet, when he had lately to construct a clock-driver of peculiar power and excellence for his 25-inch object-glass (still incomplete), he set forth before the Royal Astronomical Society of London, in a public lecture, his necessity for abandoning any revolving, and taking up with a vibrating, pendulum, though of only half-seconds length; and he apparently carried the meeting with him.

[†] These very useful restorers, if not altogether rediscoverers, are, Mr. David Gill, jun., of Aberdeen, who has still to describe his clock to the Royal Astronomical Society of London; Mr. Grubb, of Dublin, as shown in his construction of the clock-driver for the great Melbourne reflector, partially described in the *Practical Mechanic's Journal* of Glasgow for December, 1868; and Sir William Thomson, whose paper on the subject was read before the "Institution of Engineers and Shipbuilders in Scotland" on 25th November, 1868.

The only point brought out in the general discussion which followed the reading of the paper, as being decidedly new to, or specially appreciated by, the members present, seemed to be "that the revolving masses are made to press against the inside of a ring, and so check the speed when it becomes too great; a simple principle, but never applied before in practice except in Siemens' differential governor."

This method may be thus new or rare amongst steam-engines, but it is far otherwise amongst driving clock-movements, for, from the time of Fraunhofer downwards, it has always been employed therefor in Germany; and in Britain its adoption has also been frequent from early equatorial times down to Mr. Grubb's magnificent driver for the great Melbourne reflecting telescope.

But the method has not always been employed with that amount of excellent discrimination which has been shown by both Sir William Thomson and Mr. Grubb, whose chief principles therein are nearly similar, and seem to be:—First, to put stops inside to prevent the pendulum balls falling inwards to the central axis, and thereby to *make* them revolve in a circle rather than an ellipse (as they will do if left to themselves); and second, so to arrange the rubbing ring either outside or above the balls, that the instant that centrifugal force, dependent on any increased rapidity of rotation, lifts the said balls off their fixed stops to any appreciable extent, at that instant they begin to rub on the aforesaid ring and retard the velocity of revolution.[*]

The outside ring, then, thus utilized, is a very important element to the success of Sir William Thomson's governor, and deserved all the commendation bestowed upon it at the Glasgow meeting.

But yet I venture to think that there was something else in the arrangement which was just as important, just as deserving of praise, and was both newer and rarer amongst, not only the governors of steam-engines, but those of driving clock-movements also. What this other commendable feature was, however, may best appear when I describe how I fell accidentally on a parallel example of it while carrying out the improvements of the Edinburgh clock governor.

3. *The Edinburgh Clock Governor.*—The astronomical driving clock here alluded to, has been in the Edinburgh Observatory since the time of my eminent predecessor, Professor Henderson. It was supplied to him by the first optical house then in London, and the firm has made many others on the same model since then.

The driving weight was 22 lbs.; the wheelwork was contained in a rectangular case, 7·7 × 5·2 × 3·3 inches; while the governor was inside a conical cap, 4 inches high, with a mean diameter of 3·5 inches on the top of the case, and consisted in a vertical axis carrying two little pendulums hanging freely from the ends of a horizontal bar of 1·2 inch radial length.

Improvement I. Number of Pendulums.—When the above clock was set in action, the first decided fault it manifested was that the pendulum-balls, instead of rubbing smoothly, as they were intended to do, on the inside of the conical cover, would far more frequently knock from side to side, and with such a degree of violence, actually like hammers in the hands of angry elfs, as totally to ruin the regularity of the motion imparted to the telescope, and even deprive the observer of the necessary serenity of temper for nice micrometrical observations.

After being very positively and hopelessly informed by the maker that this knocking of the pendulums was a natural defect in that class of clocks and was perfectly incurable, and that they all knocked, I was so fortunate as to find that the evil was perfectly and instantly cured by adopting three pendulums, hung at 120° apart round the vertical axis, in place of *two* at 180°,[†] and the maker has since adopted this plan with the same happy results.

This is now many years ago, and the only alteration I have made on the method since, is to employ four pendulums in place of three; not because they corrected, or were likely to correct, the knocking tendency any better, but in order to allow of the introduction of greater revolving weight, and certain facilities for accurate balancing.[‡]

Improvement II. Mass and Momentum.—Although the *knocking* tendency of the Edinburgh clock was at once and for ever silenced by the adoption of three pendulums in place of two, the clock, though going better than before, yet never went really well, and never succeeded in keeping a star bisected under high magnifying power of the telescope for any sensible length of time, but was sometimes for short intervals going too fast, and sometimes too slow, to an extent of large fractions of the field of view. It would, therefore, have been utterly insufficient for the star-spectroscope observations of the present day, where the whole length of the stellar spectrum would be lost instantaneously if the place of the slit, carried by the telescope at the end of a radius of four feet, should wander by only ·003 of an inch.

What was the reason, then, of this most prejudicial irregularity?

Primarily, variations of resistance; but secondarily, I was inclined to think, a want of *mass* and *momentum*, or the essential fly-wheel power for equalizing small disturbances, in the clock's governor.

Now these features, or mass and momentum of any governor, it is well known in the long-established and thoroughly understood manufacture of *vibrating* pendulum clocks, have in practice to be increased in proportion to the accuracy of the work expected of them, and the size of the bands they have to move, or the work that they have to do. Hence in turret clocks—where the hands being several feet long, and exposed to the wind, are an approach to the circumstances of the equatorial telescope of an observatory—the pendulums are seldom less than 13 feet long, and have bobs of 112 lbs. in weight. What, then, would a maker of these well-known and widely approved clocks say, if we were to propose to him to employ therein, in place of his huge pendulums, a little thing only 1·5 inch long, and a fraction of an ounce in weight? Would he not say that such a tiny thing might do for a lady's ear-ring, but not for a working pendulum of a turret clock, intended to keep equable time under all sorts of difficult atmospheric circumstances? Yet that is the diminutive size of the pendulums furnished by London optical authority to the revolving clock-work for driving a five-foot equatorial in Edinburgh.

But a *revolving* pendulum, it may be said, moving quicker and through larger paths than a vibrating one, has more *momentum*, and makes up in that manner for deficient *mass*.

Then let us test the case in such fashion—viz., measure the space in inches passed through by the bobs of the pendulums, whether vibrating or revolving, in one second of time; and then multiplying such number of inches by the weight of the bob in pounds or parts of a pound, we shall get a single expression in number of "inch-pounds" for the *power* of each clock, as depending on mass and momentum of its governor, and we have the following table:—

Name and Character of Clock.	Power of Governor in Inch-pounds per Second.
Old Edinburgh driving clock, moving an equatorial telescope five feet long, ...	3
A common Dutch clock, showing hours and minutes on a 7-inch face, clumsily, ...	9
A good time-keeping clock, showing hours, minutes, and seconds on a 13-inch face, accurately, ...	64
David Gill, junior's, driving clock of a reflecting equatorial, admitted to perform well, ...	210
Ordinary turret clock, showing hours and minutes on a dial 6 feet in diameter, ...	1120
Sir W. Thomson's centrifugal governor for controlling divers laboratory machines, ...	2938

Instead, then, of being found anywhere amongst the last three clocks or drivers, where the work to be performed is something similar, the Edinburgh clock is actually at the very opposite end of the scale, exhibiting less power than any common kitchen clock! I proceeded, therefore, boldly to the improvement indicated to be necessary, and, with the assistance of our excellent clockmakers in this city, Messrs. Ritchie & Son, Leith Street, increased the length of the pendulums from 1·5 to 11·0 inches, and their collective weight from one-seventh part of a lb. to 9 lbs. The diameter of the path of revolution of the centre of the bobs was also increased from 3·3 to 5·0 inches; and though their rate of motion, from another reason, had to be decreased, the power of the clock's governor, expressed in the terms of the table, was made by these means nearly 70 times as great as it was before.[*]

Improvement III. Chronometric Principle.—So far as described above, we have only got a heavy fly-wheel into our clock, and a fly-wheel can be made to revolve at any pace according to the driving power. But in an equatorial clock-work movement we require, besides the fly-wheel to overcome and absorb small variations, something of a chronometer principle, which shall prevent anything above a certain rate of speed being attained, though the driving power should be increased to any extent.

This chronometric principle is, however, furnished here by the 9 lb. weight being arranged, not in the inextensible ring of a fly-wheel, but in the bobs of four pendulums, all of which are quite free to leave their back radii of support and fly outward, whenever their centrifugal force, dependent on their rate of revolution, overbalances their inward pressure from gravity.

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[*] Examples, on the contrary, of a *bad* application of frictional resistance may be seen in too many equatorial driving clocks of the present day, where, first, the pendulum balls are allowed far too much range of motion in and out, and up and down; and second, the rubbing is made to be performed, not on a large outside ring, but on a little central plate, where it sometimes gets a dose of oil, and sometimes not, to "*relieve* friction." A still worse case appears to be shown, and just as if it was the best model to follow, in the "Astronomy" of the Oxford Clarendon Press, 1867, at p. 643 (Plate 37), where the two miniature pendulum balls seem to exert no friction upon anything, but simply fly outwards as far as they choose when the forced velocity of rotation increases. In this case they are not a *regulator* of velocity at all, only an *index* of it, and will permit all variations of the driving power to produce corresponding alterations in the speed of the machine.

[†] The radial distance of suspension of each of the three pendulums was made the same as before, and the pendulums were of the same weight and size as before; in fact, the two old ones were employed again, and a third made closely like them. In this case the governor weighed nearly one-half more than it did previously; but that extra weight was not the cause of the immunity from knocking, for each of the pendulum bobs or balls had subsequently almost half its weight filed away, and still there was no knocking, much less the violent knocking in times of old with the two pendulums.

[‡] Some equatorial driving clocks perform well with only *one* pendulum, when that is a full-sized seconds pendulum (of the large weight used in the best clocks), and the suspension is that most ingenious form of two sets of springs at right angles to each other, invented and first employed, I believe, by the Astronomer-Royal for the Greenwich chronograph. That form of suspension has some special virtues, as in doing away with the friction at the bottom of an otherwise heavy revolving axis; but a seconds pendulum clock requires large space, and could not stand, as the Edinburgh clock was intended to do, on the very contracted equatorial pier; while, even if it *could* be placed there, a heavy unbalanced weight swinging round and round in a circle of considerable size in such a situation, would produce an oscillation in the equatorial pier that might be prejudicially sensible in the field of the telescope. There are also other reasons against a single revolving pendulum, which will come out under the head of Improvement IV.

[*] The driving weight at the same time has only had to be increased between two and three times, so much of the former driving power having evidently been spent in useless friction, chiefly in an extra amount of rubbing of the over-light balls against the inside of the conical cover, and partly by the crown and spur wheel arrangement (replaced now by bevelled gear) of the last pair of wheels, combined with a too small size of the last pinion. Had there been space it would probably have been better to have had rather lighter pendulums (than 9 lbs.) moving in a wider circle (than 5 inches in diameter), because then, with less friction at the base of the vertical axis carrying said pendulums, there would have been an equal amount of "inch-pounds" representing the governor's power. But there was not space enough for anything larger than the 5 inches, and I had only the opportunity of improving an old clock, already placed in an old equatorial, not of constructing a new clock for a new equatorial and new part of the observatory.

The moment, too, that the bobs do thus fly outward—*i.e.*, as soon as they have passed through one-twentieth of an inch in their outward paths—they begin to rub against an outside ring, and thereby reduce the velocity; in so far just as in Mr. Grubb's and Sir William Thomson's governors, which have already been commended.

The fixed rubbing ring is of brass, while the revolving rubber points which I have adopted are studs of leather, two for each pendulum, and placed one inch apart azimuthally: this arrangement being found, when assisted by the suspensions, which are also double for each pendulum, to enable the bobs, which have additional fixed guides below, to move outward easily, and rub smoothly, without being twisted round by the resistance outside.*

Improvement IV. Intensified Action.—Our clock is now in principle nearly everything that it should be. On being first set in motion, its governor begins to revolve, slowly and smoothly, merely as a fly-wheel; but the rate of revolution is increasing every moment, until, after a few seconds, it reaches that rate at which the centrifugal force balances the weight of the pendulum bobs, and the next moment after, they are thrown outwards against the rubbing ring; when though the driving weight is at present four times more powerful than what is just necessary to produce that rate of revolution, no quicker rate is allowed to take place by that action of the pendulums, and the friction thereby produced.

In *principle*, therefore, I may say that this is all that can be required; but in *practice* the correcting action is hardly so prompt, sensitive, or energetic, as it might be sometimes with advantage. How, then, can we produce these desirable qualities?

Not by adding more weight, or, indeed, gravity of any kind, to the driving power, which is already more than enough, and has its overplus used up by friction; and not by adding more weight or "quantity gravity" to the governor (as by an additional pound of metal to each pendulum bob), for the rate of motion would still be just the same as before: but if we can increase the *intensity* of the gravity force already acting on the governor, that will at once introduce the improvement we require; and although the idea might first of all seem an impossibility, so long as the earth itself remains of its present size and weight, yet a practical equivalent to the effects of such a grand cosmical alteration on the clock governor is not very difficult to carry out.

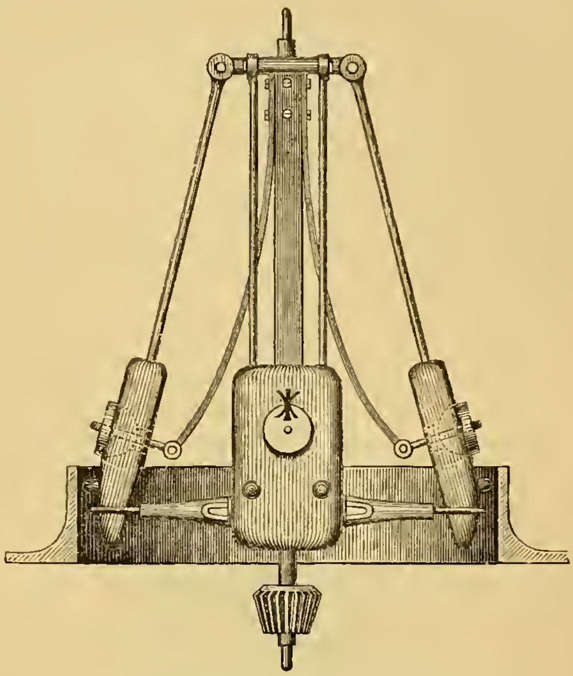
For, seeing that the action of gravity on the pendulum bobs, as at present suspended, is merely to make them fall inwards towards the central axis with a certain velocity or pressure, let us apply a central spring to increase that velocity or pressure; or thereby make them fall, if falling bodies, not at the rate of the usual and orthodox 16 feet in the first second of time as on the earth, but of, say 60 feet, as on the surface of a larger and heavier planet.

The effect of such an alteration would of course be, on a vibrating pendulum, to make it vibrate quicker than before; and on a revolving one, to make it revolve quicker; so that on this example, or the now improved Edinburgh driving clock, while without any spring pressure at all, the revolution of the pendulums is effected in 1·2 second, the screwing up of certain delicate steel springs arranged around the central axis causes the revolution to be effected in 0·7 second; and putting on certain stronger temporary springs causes them to revolve in 0·3 of a second; the rate of motion being duly and regularly maintained at that point ever after.

In so far, then, we have obtained the generally useful feature that the momentum of our governor is increased four times (in the same space and weight as before) by its speed being increased that amount; but this advantage is accompanied by the still further one of the centrifugal force being increased much more than four times, following indeed the law of the square of the velocity.† And hence, the moment that by decrease of resistance in front, or increase of driving power behind, there is any tendency to *make* the pendulums revolve quicker, say by 1 per cent., than their now accelerated and proper rate of 0·3 of a second, they are thrown off sixteen times more promptly and energetically against the rubbing ring than they were before.

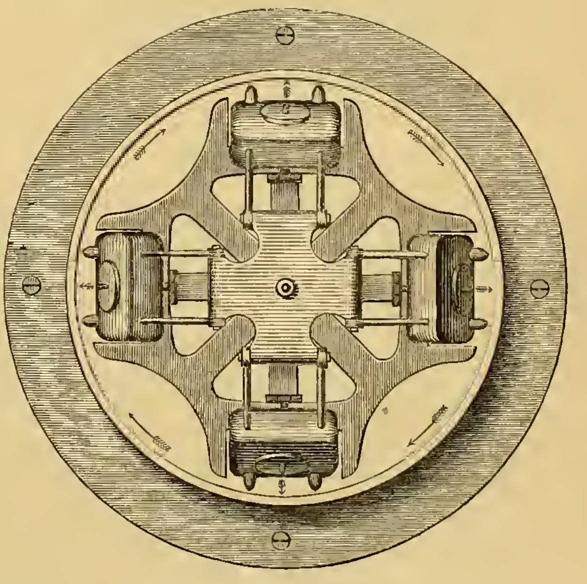
In the present clock only a moderate amount of this increased energy is intended to be imparted, and the springs, being drawn through the centres of the pendulum-bobs by fine micrometer screws, are used in part to adjust the *rate* of the clock. But on other occasions, evidently by duly increasing the central spring power (to impart *intensity* gravity to the governor), and keeping up the driving weight (in its mere *quantity* gravity) equal to the new duty laid upon it, we might obtain any degree of quickness and energy that should be thought desirable in a centrifugal governor. Nay, indeed, we might thereby realize for the curious, here on earth, the habitudes of a driving clock on any other of the planets, or on the sun itself, barring only temperature.

By a reverse action of the springs, for instance, we might produce the weak intensity of gravity on one of the least of the planetoids; when, though the pendulums were made of lead, they would revolve slowly, poorly, and inaccurately, like a feather in air. Without springs at all, we have the *terrestrial* gravity governor, sufficient for much of the jog-trot business that has hitherto been carried on in the world, but not for the exciting railway times and sudden changes we now live in. With springs directly applied and 2·7 times more powerful than gravity, the governor would revolve at the rate due to the surface of Jupiter, and would constitute an improved (quicker) and truly "Jovial governor." But if the springs were increased to 28 times the earthly pull on the pendulum-bobs, or the force of gravity on the surface of the sun, we should then behold a "solar governor," going at a terrific speed, but with an admirable regularity and undeviating accuracy which no terrestrial accidents could disturb in any sensible degree.



Elevation of new Edinburgh Clock Governor.

4. *Previous Discoverers.*—After making out this useful principle for the benefit of the Edinburgh clock-governor, I found, as well might be expected with anything at once so effective and simple, that I had been preceded by other inventors. For, not only did I receive soon after a printed account of Sir William Thomson's governor, already alluded to, and perceived therein the introduction of two strong springs to pull the revolving weights inwards towards the centre, and on which springs (as noted in p. 369) I am inclined to consider that no small portion of the admitted remarkable success of that governor depends—but I also found that Mr. Charles T. Porter, of New York, exhibited in 1862, and I believe took out patents for, two steam-engine governors embodying the same principle, and utilizing it even to an excessive extent.*



Plan of new Edinburgh Clock Governor.

Mr Porter's description of the case is certainly different from mine, but the acting result is the same, and he deserves all due praise, as he undoubtedly has, so far as I am concerned, all priority for it. He wanted *sensibility* in a governor, and says that the way to obtain it is to adopt *an initial resistance* to the outward movement of the pendulum balls of, in so far, an ordinary Watt's revolving governor.

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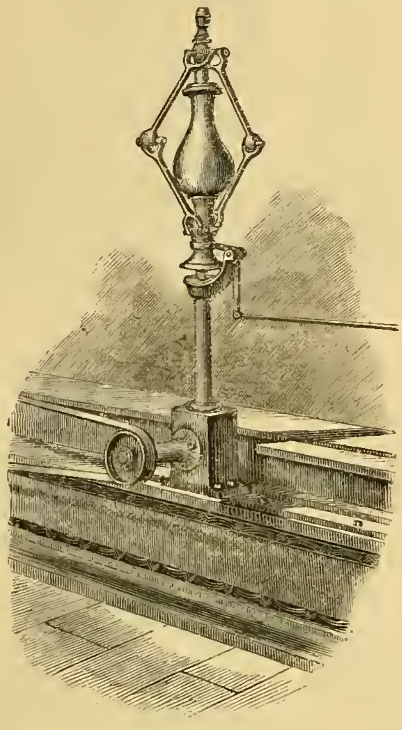
* The present apparatus acts sensibly well in this respect; nevertheless had there been more space where the clock is required to stand for a larger circle of horizontal revolution, I should have preferred to adopt for each of these four pendulums the principle, ingeniously carried out by Mr. David Gill in his mono-pendulum driver, of confining the bob to merely moving inwards or outwards within a radial frame, and allowing a sliding arrangement of that frame to bear all the stress of the side friction against the fixed rubbing ring. In this manner, too, not only is all that most prejudicial *side* stress of the act of rubbing borne by the frame, not by the pendulum, but there is the further advantage that the act of rubbing being performed on a circle of larger radius than that of the pendulum-bob's own circle of revolution, it becomes a more practically powerful method of reducing extra speeds, even as we have conversely seen, in the note to chap. 2, p 370, that the defective action of not a few existing equatorial clock governors is owing to their exerting their rubbing pressure on small central plates, or on a circle of much *smaller* size than the balls revolve in.

† Centrifugal force $= \frac{\text{velocity } 2 \times \text{weight}}{g \times \text{radius}}$
where $g =$ the force of gravity.

* See the *Practical Mechanic's Journal* "Record of the Great Exhibition of 1862," pp. 233 and 234. London and Glasgow: Longman & Co.

Such an initial resistance, accordingly, either by weight or spring, Mr. Porter puts on, and then applies a quicker rate of revolution to enable the balls to overcome that extra resistance. In so far there might seem to be nothing gained or altered, except that the revolving balls may be made much lighter than before, and still have momentum and power sufficient to work the steam cut-off; and, in fact, so long as the variations of either resistance or driving power of the engine are *slow*, there is nothing to choose between the heavy Watt governor balls revolving slowly and the light ones of Porter revolving quickly. But if the variations of resistance or driving power are *sudden*, then comes a visible difference between the two governors; for the big Watt balls can only expand outwards sluggishly and leisurely after the mischief is begun, while the little Porter balls fly out quickly and violently at the instant—their centrifugal force having increased far faster than the velocity, or according to the *square* of the velocity.*

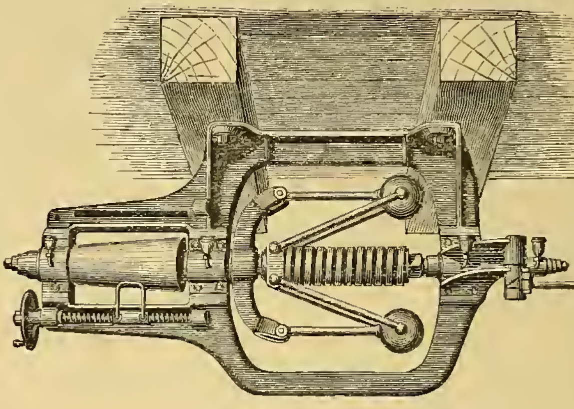
In fact, so suddenly and efficiently do the Porter balls fly outward, that a certain so-named "Allen engine," when governed by it, and running heavily loaded, had its whole load suddenly removed by slipping off the driving belt, and all that took place was this—not any racing of the engine, and beating itself to pieces, but a sudden outward movement of the governor to cut off the steam, and *no* sensible variation in the speed of the engine.†



Porter's Land Governor.

5. *Application to Screw Steamers.*—When the controlling action of *intensified* gravity is thus admirably and even inimitably quick and powerful, and when one of Mr. Porter's forms of it depends chiefly on a spring ‡—and a spring overbalancing the mere weight so much as seventy times—this variety of the governor would seem to be admirably adapted (when modified by having three or more pendulums in place of two only, for the reasons given in chapter 3) to save many screw-steamers from some of the most serious perils they are liable to. How great these perils are is sufficiently proved by the number of disasters recorded in the daily papers, and the frequency with which a screw-steamer in distress forms an episode in every modern storm occurring at sea.

The recent melancholy wreck of the *Hibernia*,* when duly analyzed, is a case in point. But allow me rather to begin by describing *some* of the *preliminaries* to an average screw-steamer catastrophe, as they occurred day after day, under my own observation, in another vessel of large size and on an ocean voyage.



Porter's Marine Governor.

When the weather thereon was fine and the sea smooth, the sound of the screw was merely that of a continual churning and rushing of bubbling water, to whose gentle murmuring the lady passengers sang sweet songs, and the captain, being of rather a musical turn, played pensive airs on a soft accordion. But when the wind blew and the waves rose, suddenly there came a bang like the report of a cannon under the floor of the vessel, and the whole saloon quivered from end to end.

"What's that?" exclaimed half-a-dozen passengers in alarm.

"Oh! it's the screw," pleaded the captain; "because, you see," said he, "whenever the stern of the vessel is over a trough between two big waves, the screw gets out of the water, and then it spins round awfully quick, as quick as it can go; but presently up comes the water again, and smack goes the blade of the screw upon it with a thundering blow, as if it had hit on a rock."

Long before this explanation was finished, had come another, and even another still, of those terrific bangs with the following quiverings and shudderings of the whole ship. Indeed, the blows were sometimes repeated at the rate of two or more a minute, and for every minute, with little cessation during a day and a half.

"But why don't you put on governors to *prevent* the screw spinning round when it gets out of the water?" we asked; "for if you allow all the force of your two-hundred horse-power engine to go on thumping the ship in that dreadful manner there will be a molecular (brittle) crystallization set up in the interior of the iron—which no Board of Trade examination will find out; and one of these bad days the big screw-shaft will snap in consequence, or the iron plates will crack, or the heads of the rivets be cut off, and you will founder in deep water."

"That's precisely what I expect we shall do," returned the captain; "for there are no governors of any kind on the engine; and our orders are never to let the furnaces get low, but always to keep up the steam to the full pressure of the boilers, in order to make quick voyages, no matter whether this thumping of the ship takes place or not; and as the owners are fully insured, and are not on board, it's all the same to them whether we sink or float."

Now if this really represents the condition, and I believe that it does, of many of our sea-going screw steamers—with their precious burden of human lives—one of the chief and most insidious dangers they are exposed to can certainly be largely relieved by employing the quick-acting governors of *intensified gravity* action; governors so quick and powerful as to prevent the screw revolving any quicker in air than in water.

Indeed with such governors on board, the first getting loose of the screw, thumping of the stern-post, cracking of the screw-shaft, and "racing" of the engines on board the ill-fated *Hibernia*—all which features were the prelude to her miserable sinking or being sunk—would never have occurred; and her screw-shaft might still be in excellent order. When the means of safety, too, are so simple, cheap, and portable, the underwriters would probably be fully supported by public opinion and the law too, if they were in future to refuse to pay any compensation on the "total loss" occurring of any ocean-going screw steamer, which shall be recklessly sent to sea—*i.e.*, in such case to destruction—without either *intensified gravity* governors or some other good ones of at least equal promptitude and energy.

MONTHLY NOTES.

Lespes' Carriage Brake.—M. Lespès, of Paris, has designed a system of brake for carriages, the distinctive feature of which consists in fixing the piece intended to retard the motion of the wheels on the axle itself, in lieu of on the carriage body as heretofore, by which the unpleasant shocks experienced by passengers when the brake is applied are greatly diminished. At the inner end of each box a disc is provided, which carries a pair of ratchet wheels, one on each side, with the teeth in opposite directions. A horizontal rod is rigidly secured by arms to the axle, so as to stand out at a short distance therefrom. This rod carries a friction brake, which acts on the surface of the disc, and a pawl and detent; the former when put into gear with one of the ratchet wheels, instantaneously arrests the motion of the carriage, whilst the latter is in permanent contact with the other ratchet wheel. The friction brake and the pawl are both actuated by foot boards standing up from the floor of the coach box, and which are in connection with the horizontal rod. When the motion of the wheels is arrested by the pawls, the force with which the ratchet wheels strike against the pawls causes the latter to recoil before them, at the same time depressing a little the horizontal rod; and as the rod is dependent on the axle, this motion is transmitted to the springs fixed on the latter, and thence to the carriage body. The shock is thus considerably reduced and its direction changed, it being converted into a horizontal forward motion, followed by a back motion when the brake regains its position; and we are informed by those who have ridden in a carriage to which this system of brake is applied, that the shock experienced by passengers at the time the brake is put into action is almost imperceptible.

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* It may be considered that Mr. Grubb also has employed some amount of intensification of gravity in the centrifugal driver of his Melbourne equatorial, though without springs or accessories, but merely by laying down the pendulums at a large slanting angle from the vertical. For, although in such a position the usual rule for comparing the rate of revolution of a conical pendulum is, to take for its acting length the *vertical* height, which, in such position as the above, is of course decreased, and therefore gives quicker rotation—yet a more suitable consideration, with a revolver having such long horizontal fixed arms and short pendulums as Mr. Grubb's, might be to consider the weight or pressure which the bobs exert on their seats (evidently a function of the angle of their rods, irrespective of their length, from the vertical), and then to ascertain what rate of revolution will produce sufficient centrifugal force to lift such weight. The *adjustment* of rate of such a governor might be easily contrived by alteration of the length either of the upper suspension bar or lower supporting bar of the pendulum, the former in increasing making the clock go slower, and the latter faster. But the range of the method is limited in practice, seeing that when the pendulum rod is nearly horizontal its correcting movements under even a large increase of centrifugal force must be merely microscopic.

† See Mr. Mallet's statement in the *Practical Mechanic's Journal* "Record of the Exhibition of 1862," p. 233.

‡ Weight of balls = 12 lbs. each; circle of revolution of balls, from 10 to 15 inches in diameter; rate of revolution = 450 turns in one minute; initial compression of the central spring = 1600 lbs.

* The screw steamer, not the sailing vessel, of that name.

THE LATE MR. JOHN DICKINSON, PAPER-MAKER.—We of the present day, with our newspapers issued daily by the hundred thousand, can form but a faint idea of what was the state of the paper manufacture, now so important a branch of industry in this country, even at so late a period as the commencement of the present century. Instead of paper being reeled off in webs many feet in width, and at the rate sometimes of upwards of a mile in the hour in length, each sheet had at that time to be made separately on a mould by hand, and had then to be subjected to various subsequent processes before it was in a state fit for use. To obtain an uniform and continuous supply for any purpose was almost a matter of impossibility, and the necessity of applying machinery to this manufacture was beginning to be felt, while the success which had attended its introduction into the spinning and weaving industries gave encouragement of success. Yet the whole change from a system of manufacture almost mediæval in its rudeness was comprised within the lifetime, and was in great measure effected by the exertions and ingenuity, of the gentleman whose name we have placed at the head of this paragraph, and who was buried on Monday last at Kensal-green. John Dickinson, eldest son of Captain Thomas Dickinson, R.N., was born on the 29th of March, 1782, and had, therefore, nearly completed his 87th year at the time of his decease. His father, of a north country family, was himself the son of a naval captain, and his mother came of an old French family, the Cossés, of Brissac, though her immediate ancestors had been driven by the revocation of the Edict of Nantes to settle in this country. It is probable that, as has been the case in many other instances, it was to this infusion of French blood that much of the inventive faculty to which Mr. Dickinson owed his subsequent success was due. The intimacy subsisting between Captain Dickinson's family and Mr. Andrew Strahan, at that time the king's printer, influenced his future career as connected with the supply and manufacture of paper. On the expiration of his indentures he commenced business in Walbrook, and shortly after joined Mr. George Longman, brother of the late Mr. Longman, of Paternoster-row, and for some time M P. for Maidstone, and carried on business with him, and subsequently with his nephew in the premises in the Old Bailey, so long associated with the name of Dickinson & Co. It was not, however, until the year 1806 that the first patent "for manufacturing paper of an indefinite length" was taken out by Henry Fonrdrinier, and this was soon followed by Mr. Dickinson's patent of June 30, 1807, for machinery for cutting and planing paper thus made. Fonrdrinier's patent for the paper machine, which still bears his name, was taken out in the same year; and it was about this time that Mr. Dickinson commenced his career as a paper manufacturer by the purchase of Apsley-mill near Hemel Hempsted, to which in the course of time four other mills in Hertfordshire were added, two of them constructed and the water power for them created under his own superintendence. It was in 1807, before the commencement of the Peninsula campaigns, that he invented a new cannon-cartridge paper, made by mixing together linen and woollen rags in certain proportions, so that after the explosion it was prevented from retaining sparks of fire. In 1809 he patented machinery for the manufacture of paper by means of an ingeniously constructed cylinder of brass, covered with wire gauze and connected with an air-pump, a form of machine which still remains in use. This was followed by other patents for the manufacture of finely-faced copper-plate paper by a sort of veneering process, and for a machine to cut cards, both of which were successful inventions, and the former especially tended much to increase his reputation. In 1829 he invented the process of introducing coloured threads into the body of paper at the instant of its manufacture, which was again improved on in 1839. This preservative against forgery will have been noticed by holders of Exchequer bills, and many of us will remember it in the stamped envelopes which were issued by government after the adoption of the penny postage system, in the introduction of which Mr. Dickinson had taken great interest. In 1832 we find him again patenting a knotter or strainer for cleaning pulp from impurities, and two years later applying magnets for the removal of any portions of iron that may happen to be in the pulp, and thus preventing iron-mould in the paper. Besides these, he took out other patents for improvements, more or less important, in the manufacture of paper, almost up to the period of his finally retiring from business in 1857. Such is a brief outline of the principal inventions of Mr. Dickinson in connection with the manufacture, of which he must be regarded as one of the founders, and of which he was for so many years the recognized chief. But his energies were not confined to manufacturing and mechanical details; his friendship with the principal publishers of London and Edinburgh was intimate and lasting, and brought him in contact with most of the distinguished authors of his day. He was a member of many of the learned societies, and was in 1845 elected a Fellow of the Royal Society, to which he communicated, in 1851, some observations on the supply of water from the chalk stratum in the neighbourhood of London, containing much valuable information as to the percolation of water through chalk. In his latter years he took much interest in astronomy, and erected an observatory at his country house, Abbots-hill, of which he had been at once architect and builder. As a magistrate he took an active part in the general concerns of the county. He was a liberal benefactor to numerous charitable institutions, and especially to hospitals, and was for many years one of the registrars of the Royal Literary Fund. His mental and bodily activity was extraordinary, and in the words of one of his oldest friends, "he had thoroughly lived out his life, and had found time and means to crowd into the short intervals of business more kindly and generous deeds than would make the staple of many ordinary men's lives."

IRON-CLAD FLEET OF GERMANY AND ITALY.—The *Revue Maritime et Coloniale* gives from an Austrian source the following particulars of the iron-clad fleet of North Germany. The fleet consists of five ships—the *Prince Adalbert*, *Arminius*, *Prince Royal*, *Frederick Charles*, and *King William*. The two first are cupola ships with three guns; the two next mount sixteen, and the last twenty-four guns. All the guns are rifled breech-loaders of Prussian construction. All the ships are of iron with the exception of the *Prince Adalbert*, which is a wooden vessel, and is also the smallest of the fleet, its tonnage being only 681, with engines of 300 (nominal) horse-power. The *King William* is the largest of the five, with a tonnage of 5939 and engines of 1150 horse-power. Two were constructed in France, one by M. Arman, of Bordeaux, the other by the Forges et Chantiers Company of the Mediterranean. The remaining three were built in England—two by Messrs. Samnda, of London, and the third, the largest, at the Thames Ironworks. The thickness of the plates used for these vessels varies from 4½ to 8 inches. "Les Luttes de l'Autriche en 1866," the first volume of which has lately been published, states that the Austrian sea-going iron-clad fleet consists of two frigates of the first class, three of the second, and two of the third. They carry an aggregate of 213 guns and 2592 men. There is also an iron-clad battery of position, with an armament of 16 guns and a crew of 229 men. The same publication gives the strength of the Italian iron-clad fleet at four frigates of 36 guns, four of 26, and three of 22 guns each, one ram with 2 guns, two corvettes of 20 guns, two sloops of 4 guns, and two batteries with 12 guns each—in all eighteen vessels, with an armament of 388 guns and an equipment of 7358 men.

THE SUEZ CANAL.—During the month ending 15th November, the excavations for the Suez Canal amounted to 2,102,000 cubic metres. This is the fourth month in which the excavation has exceeded 2,000,000 of cubic metres. Six steam dredging machines on the canal, between Port Said and Rasa El-Ech, excavated 313,628 cubic metres, or on the average 52,271 cubic metres each. The quantity, however, excavated by one of these dredgers amounted to 88,889 cubic metres, or near 3000 cubic metres per day. The position of these works up to the 15th November was as follows:—

	Cubic Metres.
Amount excavated up to 15th October, 1868, . . .	51,347,718
Amount from 15th October to 15th November, . .	2,102,000
Total amount excavated up to 15th November, . .	53,449,718
Remaining to be excavated, ...	20,662,412
Total excavation in line of canal, ...	74,112,130

THE MONT CENIS TUNNEL.—During the first fortnight of the past month (December) the progress made at the Mont Cenis tunnel was 41·15 metres, of which 20·80 metres were driven at the Italian side, at Bardonnèche, and 20·35 on the French, at Modaue. The position of these works up to the 15th December was as follows:—

Length driven at Bardonnèche, ...	5,340·20
Length driven at Modane, ...	3,776 95
Total length driven, ...	9.117·15
Length remaining to be driven, ...	3,102·85
Total length of tunnel, ...	12,220·00

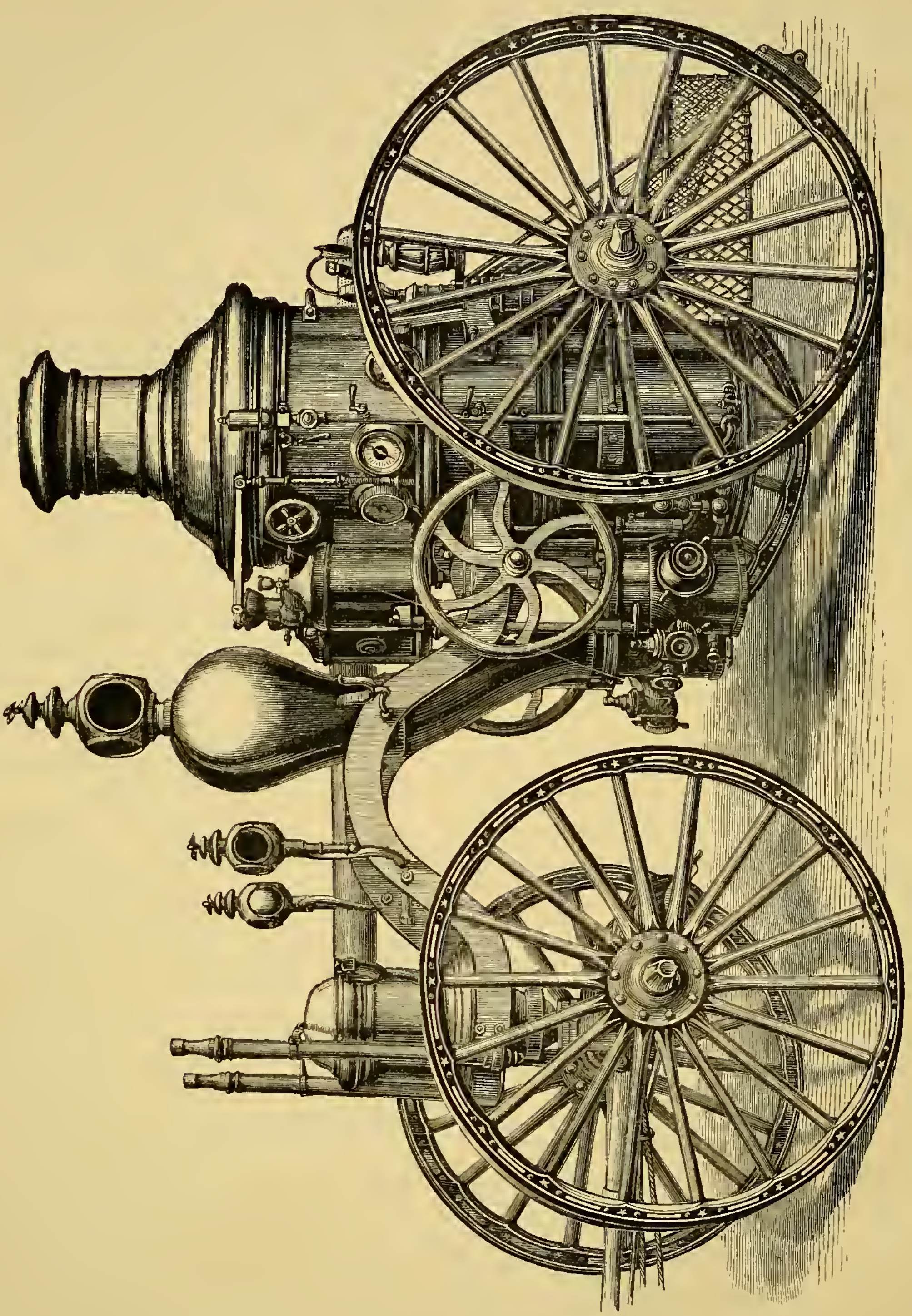
CULTIVATION OF THE CAUCASUS.—A company, which has recently obtained for sixty-five years a grant of a large tract of land in the Caucasus and on the Persian frontier, is about to raise a capital of 12,500,000 roubles in shares. This capital is to be employed in the following manner:—8,500,000 in works of irrigation necessary for preparing the lands for the production of wheat and other cereals, madder, and cotton; 3,000,000 in the construction of factories and works much required in the Caucasus, and 1,000,000 in making loans to proprietors of land, and in the establishment of a bank which it is proposed to found at Tiflis.

ACTION OF WATER ON LEAD.—Professor Parkes, F.R.S., of Netley, calls attention to the fact that it has always been seen that the action or non-action of water on lead could not be entirely accounted for by the usual statements on the subject, and lately Dr. Frankland has made a curious observation, which may throw light on the subject. He found that water which acted on lead lost this power after passing through a filter of animal charcoal. He discovered this to be owing to a minute quantity of phosphate of lime passing into the water from the charcoal; on comparing two natural waters, that of the river Kent, which acts violently on lead, and that of the river Vyrnwy, which, though very soft, has no action on lead, he found that the latter water contained an appreciable amount of phosphate of lime, while none could be detected in the Kent water. This observation may probably explain much of the discrepancy of evidence in respect of the action of soft water on lead.

PROPOSED TUNNEL UNDER THE MERSEY.—On the 21st December last a meeting was held at the Cotton Sales-room, Liverpool, Mr. Patterson, President of the Chamber of Commerce in the chair, to hear explained the project of making a railway tunnel under the Mersey, connecting Liverpool and Birkenhead and the Lancashire and Cheshire Railway termini. Sir Charles Fox said that the engineering difficulties were comparatively slight as compared with those encountered in making the Thames Tunnel. The preliminary expenses for the "heading," which could be afterwards used for gas pipes, telegraph wires, &c., would not exceed £20,000, and the cost of the entire tunnel, with two lines and rolling stock, would not exceed £460,000. The metropolitan underground railways are successful, and at present twenty millions of people crossed the Mersey annually. Resolutions in favour of the scheme were unanimously agreed to. We understand, however, that it has, for the present at least, met with no support, and may be viewed as abandoned.

THICK AND THIN IRON PLATES.—The stoutest iron plate made is manufactured by John Brown, of Sheffield, has a thickness of 15 inches, and is used as armour-plate. The thinnest plate is produced by Messrs. Hallem & Co., and is so attenuated that 4800 sheets of it, laid one over the other, are only 1 inch in thickness.

American Steam Fire-engine.—Not the least among the progressive steps made during the past few years, in the application of mechanical improvements, has been the substitution of the steam fire-engine in the place of the comparatively inefficient hand apparatus formerly in use. Much effort and inventive skill has been expended in securing the essential requisites involved in raising steam rapidly and keeping up the working pressure in a uniform manner, together with the no less necessary characteristics of simplicity, strength, durability, and lightness of construction. When all these points have been considered and obtained in the requisite degree, there still remains that of manageability, or the capability of being easily operated by a single person in throwing a greater or less quantity of water with any desired degree of force. The accompanying engraving illustrates a double steam fire-engine, in which it has been sought to embody all of the above specified advantages, including that last mentioned. The engraving is a correct representation of the engines No. 1, of the City of Brooklyn, and No. 33, of New York City. To set forth more in detail the advantages claimed for this apparatus, it may be mentioned that with other steam fire-engines it has been necessary to work the engine at a greater or less degree of speed, according to the force and velocity with which it was desired to discharge the water. In many cases it is required to discharge several streams at once, or a stream of unusual size, and in this event the ordinary engine can hardly meet the demands upon it to supply the entire quantity of water needed. In some other instances, where a very long length of hose is used, a high pressure is required, and the engine running slow is liable to stick on the centres, and as a consequence of the irregular pressure upon the hose the latter is frequently ruptured. The manufacturers of the improved apparatus of which we are speaking assert that each of these defects is overcome in their engines, as well by careful workmanship, selection of materials, and appropriate design, as by the judicious arrangement and proportioning of the parts. It should be mentioned, furthermore, that not only may the quantity and force of the water discharged be varied with reference to the steam pressure and to the speed of the engine, but it may also be regulated by the pumps independent of either; thus obviating all difficulties springing from the impossibility of perfectly adjusting the speed of the engine, or securing uniformity in the steam pressure. These engines having two cylinders and two pumps, constitute the sizes 1 and 2 made by the manufacturers; the sizes 3 and 4 being made with single



cylinders and pumps. Any further information regarding either of these may be obtained by addressing the Gould Machine Company—*American Artizan.*

Pasquay's Furnace.—The arrangement of furnace represented in figs. 1 and 2 is designed by M. F. Pasquay, of Wasselonne, with a view to the prevention of smoke. Its chief peculiarity consists in the use of fire-bars of the form of a catenary curve, along which the fuel fed in small quantities becomes distributed in an even and uniform layer. The example chosen supposes a large consumption of fuel, in which case it is desirable to have two furnaces side by side, separated by a partition of refractory material extending up to the height of the fire-bridge. The axes, x *x*, of the curve are proportioned so as to correspond to the coefficient of friction of the coal on the cast iron.

Fig. 1.

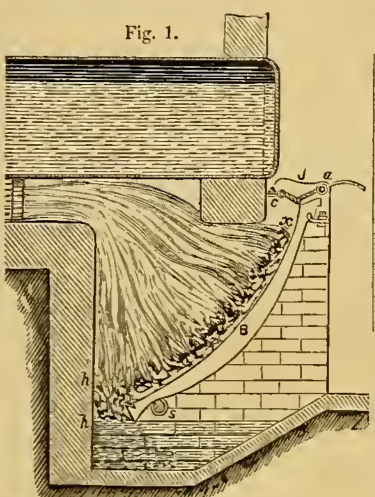
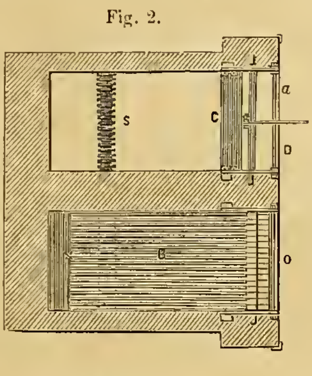


Fig. 2.



The bars are hooked at their upper end to a cast-iron cross bar, D, and their lower end rests on a support, S, each bar fitting into one of the semi-annular grooves formed around it. The cheeks, J, form with the damper, *c*, and the ends of the bars a hopper for the reception of each fresh supply of coal. The damper, *c*, is retained in the position indicated by means of a jointed rod hooked to the cross piece, *a*, which connects the two cheeks; by unhooking the jointed rod, the damper is caused to turn around its upper edge, and the charge of coal prepared falls on to the upper end of the grate. As the combustion of the fuel proceeds, the bed or layer of coal distributed along the grate gradually sinks without any gaps occurring, and when the level is sufficiently reduced a fresh charge is supplied, and so on in succession. It will thus be seen that by means of this arrangement the necessity for opening the fire door either for the purpose of feeding or clearing out the grate is entirely avoided, the stones and other incombustible bodies being carried along with the ashes into the ash-pit. The ashes accumulated require to be stirred from time to time in order to keep their level down between the heights, *h* and *h'*. The cost of these furnaces is comparatively small, since as the grate does not exercise any thrust on the front the iron work is reduced to the greatest simplicity, whilst the continuity of the feeding operation admits of the use of small coal without the inconvenience of the formation of smoke.—*Le Génie Industriel.*

APPLICATIONS FOR

PROVISIONAL PROTECTION FOR INVENTIONS

UNDER THE PATENT LAW AMENDMENT ACT.

☞ When the city or town is not mentioned, London is to be understood.

6th January, 1869.

39 H. L. Vallée, H. A. Dourlet, and A. M. H. Armand, Paris—Artificial flowers
40 J. S. Gisborne, Liverpool—Mechanical telegraphs
41 E. Robins, Somers Town—Perforated tubular casts
42 K. Walter, Wicklow—Sulphuric acid
43 A. Tyler, Mark Lane—Bon-bons
44 W. Piddiog, Walcot Square—Treating plants

7th January, 1869.

45 G. Eveleigh, Bow—Purifying mineral oil
46 J. Mansergh, Westminster—Stench traps
47 J. F. Cooke, Cannon Street—Copying ink
48 H. Davey, Adelphi—Injecting water
49 F. N. Gisborne, West Strand—Sewing machines
50 F. R. A. Glover, Bury Street—Ships' anchors
51 J. H. Johnson, Lincoln's Inn Fields—Cakes.—A com.
52 W. Webster, Dundee—Treating jute
53 J. J. Rodmer, Newport—Iron and steel
54 H. G. Fairburn, Goswell Road—Compressing coal
55 C. Rendall, Mile-End—Working railway breaks

8th January, 1869.

56 J. Mangnall, Glasgow—Preparing coffee
57 W. Tatham, Rochdale—Spinning cotton
58 T. P. Lucas, Bromley, and G. H. J. Holt, Sydenham—Cartes de visite
59 J. Daglish, Seaham Harbour—Lubricating axles
60 R. Wigram, Leeds—Horse ploughs
61 A. B. Brown, Cannon Street—Raising weights
62 W. T. Waite, Salisbury Square—Saccharine matters
63 T. B. Sydserff, Ruchlaw—Ballot voting apparatus
64 J. Rodgers, Sheffield—Saw hardening furnace
65 M. Wilkin and J. Clark, Paddington—Railway breaks
66 J. Henderson, Castle Douglas—Iron and steel

9th January, 1869.

67 W. E. Gedge, Strand—Boxes for preserving positions.—A com.
68 R. Legg, Clerkenwell—Steam as a motive power
69 F. S. Thomas, Islington—Railway passenger carriages
70 M. Saunders, Tipton, and H. Forrest, Oldbury—Refrigerators
71 E. Gray, Sheffield—Plough coulters
72 T. Moore, Southwark—Rotary engines

11th January, 1869.

73 A. Baumann, Strand—Hydraulic cranes
74 J. Holding, Manchester—Temples for looms
75 F. N. Gisborne, West Strand, and H. Allman, Ampthill Square—Railway train signals
76 J. Knowles, Droylsden—Weaving terry counterpanes
77 J. & J. Jordan, Liverpool—Propelling vessels
78 T. A. Warrington, Saint Pancras—Window blinds
79 J. B. Palmer, Handsworth—Fire-arms
80 J. Petrie, Rochdale—Washing wool
81 W. H. Penning, Jermyn Street—Signalling by compressed air
82 C. W. Sponge, Clapton Park—Railway carriages
83 J. H. Johnson, Lincoln's Inn Fields—Paper boxes.—A com.
84 F. C. Matthews, Great Driffield—Indian corn
85 C. Newsome, Coventry—Milk cans

12th January, 1869.

86 C. M'Dougall and C. H. Eden, Manchester—Ladies' dress suspender
87 W. E. Gedge, Strand—Power looms.—A com.
88 A. Henry, Edinburgh—Fire-arms
89 A. P. Price, Lincoln's Inn Fields—Naphthaline colours.—A com.
90 B. Hunt, Lincoln's Inn—Water meters.—A com.
91 Sir F. Sykes, Isenhurst—Defending ships from projectiles
92 A. V. Newton, Chancery Lane—Knitting machinery.—A com.
93 D. L. Coates and Q. Dunlop, Belfast, and W. Orr, Ligoniel—Gearing couplings
94 C. E. Brooman, Fleet Street—Velocipedes.—A com.
95 G. V. Osborne and A. J. Peerless, Goswell Road—Ball valve

13th January, 1869.

96 H. Aitken, Falkirk—Lamps
97 S. Jellymann Cannock—Reaping machines
98 C. J. Gunther, Mark Lane—Preserving meat.—A com.
99 P. M. Barnett, Aberdeen—Railway chairs
100 J. Steel, Glasgow—Sanitary arrangements
101 L. Sterne, Westminster, J. A. Jaques and J. A. Fanshawe, Tottenham—Elastic rubbers
102 J. Parker, Camberwell—Propelling vessels
103 L. Hannart, Clerkenwell—Moulding discs
104 J. Schlosser, Finsbury Place—Metallic packing
105 W. R. Lake, Chancery Lane—Uniting pipes.—A com.
106 C. P. Coles, Bonchurch—Protecting ships' bottoms

14th January, 1869.

107 G. D. Kittoe and P. Brotherhood, Clerkenwell—Valves
108 W. M'Donnell, Limerick—Churns
109 R. Watson, Birmingham, and B. Dangerfield, West Bromwich—Chronographs
110 J. R. Hodgson, Limehouse—Life buoys
111 T. Mortlock, Hoxton—Dressing millstones
112 E. P. North, Birmingham—Pocket railway reading lamps
113 H. Vavasseur, Southwark, and C. M. Wade, Furnival's Inn—Railways.—A com.
114 A. V. Newton, Chancery Lane—Mowing machinery.—A com.
115 W. E. Newton, Chancery Lane—Steam pumps.—A com.
116 J. H. Kitson and J. Kirby, Leeds—Movable grates
117 T. Cook, Old Kent Road, and J. Watson, Westminster—Oil presses
118 A. M. Clark, Chancery Lane—Breech-loading fire-arms.—A com.
119 T. Birkett, Birmingham, and H. Scott, West Bromwich—Breech-loading fire-arms

15th January, 1869.

120 H. L. Harris, Aldgate—Packing cases
121 C. H. Lea, Stafford—Opening and closing gates
122 J. Steel, Glasgow—Washing casks
123 A. De P. Chance, Birmingham—Step-ladders.—A com.
124 J. O. Smith, Barrow-in-Furness—Iron and steel
125 H. Fowkes, Manchester—Cleaning gun barrels
126 D. P. Wright, Birmingham—Window blinds
127 W. Tijou, Westminster, and W. Whieldon, Lambeth—Getting coal
128 A. Sehet, Paris—Breech-loading fire-arms
129 W. H. Brookes, Sheffield—Door fastener.—A com.
130 P. Spence, Manchester—Sulphate of potash
131 T. Howcroft and A. M'Gregor, Bedford Leigh—Reaping machines
132 E. Craddock, Camberwell New Road—Portable punch
133 M. Boyce, Abchurch Lane—Apparatus for scoring at whist
134 A. H. A. Durant, Shepherd's Bush—Castor oil

16th January, 1869.

135 T. A. Warrington, St. Pancras—Spoons
136 J. T. Bintley, Kendal—Connecting rails
137 S. Russell, Brixton—Velocipedes
138 R. Craig, Dalkeith—Paper
139 J. Jeavons and W. Waplington, Sheffield—Iron and steel
140 J. G. Johnson, Coombe Fields—Signalling apparatus
141 J. H. Johnson, Lincoln's Inn Fields—Casks.—A com.
142 H. A. Silver, Bishopsgate Within—Cooking apparatus.—A com.
143 J. Bourne, Leith—Propelling vessels
144 J. Loader and W. H. Child, Finsbury—Steam-boilers
145 W. and D. Bottomley, Rochdale—Cotton rollers
146 W. Thomas, Cheapside—Boots and shoes
147 J. B. Whitehall, Nottingham—Looped fabrics
148 F. Braby, Camberwell—Sulphate of ammonia
149 L. B. Phillips, Queen's Square—Fac-similes of works of art
150 W. R. Lake, Chancery Lane—Figured shawls.—A com.
151 M. Henry, Fleet Street—Moulding metal articles.—A com.

18th January, 1869.

152 W. Pidding, Walcot Square—Mosaic textile fabrics
153 P. H. Platt, Ashton-under-Lyne—Looms for weaving
154 N. Voice, Handcross—Urinals
155 C. Catlow, Burnley—Looms for weaving
156 J. D. Thomas, Liverpool—Artificial bust
157 P. Oldfield, Bradford—Combing wool
158 R. H. Clarke, Evesham—Silk cloths
159 G. R. Postlethwaite, Birmingham—Screw nuts
160 J. W. Price, Abergavenny—Horse shoe nails
161 W. R. Lake, Chancery Lane—Propelling machinery.—A com.
162 G. Brown, Edinburgh—Gas meters
163 J. H. Johnson, Lincoln's Inn Fields—Burning bricks.—A com.
164 A. M. Clark, Chancery Lane—Refining sugar.—A com.
165 H. and J. Parnall, Bristol—Scale beams
166 W. T. Eley, Gray's Inn Road—Cartridge cases

19th January, 1869.

167 F. G. Archibald, Edinburgh—Cleaning boots and shoes
168 M. Burke, Liverpool—Ships' skylights
169 G. Lowry, Salford—Hackling machines
170 W. and J. Pain, Stepney—Floor rug
171 H. W. Hammond, Manchester—Driving piles.—A com.
172 J. Armstrong, Rotherham—Railway switch apparatus
173 C. Baunscbudt, Bonn—Treating rheumatism
174 N. D. Spartali, Liverpool—Propelling vessels
175 W. R. Lake, Chancery Lane—Railway carriages.—A com.
176 C. E. Brooman, Fleet Street—Breech-loading guns.—A com.

20th January, 1869.

177 G. A. Crow, Newcastle-on-Tyne—Radial drilling machines
178 J. Siddeley, and F. N. Mackay, Liverpool—Ice-making apparatus
179 F. A. Paget, Adelphi—Steam-boilers.—A com.
180 W. Gillett, and C. Bland, Croydon—Bell chimes
181 J. Edwards, Hackney—Railway trains
182 E. Burton, Upper Clapton—Sand-distributing machine
183 E. Barcroft, Rawtenstall—Cocks
184 P. C. Evans, Brimscombe Mills, and H. J. H. King, Glasgow
185 M. J. Matthews, Glasgow—Harmoniums
186 H. A. Bonneville, Piccadilly—Illuminating gas.—A com.
187 H. A. Bonneville, Piccadilly—Piano-fortes.—A com.
188 F. Lipscombe, Strand—Storing water
189 C. De Bergue and C. Faare, Strand—Locomotives
190 D. Spooner, Kilburn—Rice mills

21st January, 1869.

191 J. W. Wilson, Barnsley—Steam boilers
192 J. C. L. Camel, Lyons—Surgical bandage
193 D. Rivenc. Geneva—Cutting millstones
194 A M. Clark, Chancery Lane—Scarf fastenings.—A com.
195 C. J. Chubb, Tavistock Square—Coal drills
196 T. C. Lewis, Brixton—Steam engines
197 C. G. Gumpel, Leicester Square—Key-hole plates
198 F. Walton, Staines—Artificial marble
199 W. R. Lake, Chancery Lane—Shearing animals.—A com.

22nd January, 1869.

200 R. Baxenden and J. Heald, Chorley—Looms for weaving
201 A B. Cunningham, Woolwich—Horse-throwing apparatus
202 B. Craig, Branthwaite—Communicating in railway trains
203 M. Tildesley, Willenhall—Annealing cans
204 J. Wilkins, Nottingham—Looped fabrics
205 J. Speight, J. E. Burton, and E. Brooke, Bradford—Spinning wool
206 A. Maw, Broseley—Moulding china
207 F. R. Ensor, Nottingham—Ensor lace
208 T. Cook, Old Kent Road, and J. Watson, Westminster—Motive power
209 J. W. and J W. Horsfield, Dewsbury—Steam-boilers
210 W. E. Gedge, Strand—Slate cutting machines.—A com.
211 W. Dennis, Aldermanbury—Letter-boxes.—A com.
212 W. Burgess, Newgate Street—Mincing machines
213 J. Beattie, Surbiton—Buffing apparatus for railways

23rd January, 1869.

214 J. Millward, Birmingham—Quarrying stone.—A com.
215 J. Ortton, Wandsworth Road—Locomotive cylinders.—A com.
216 E. Simons, Sheffield—Communicating in railway trains
217 W. Huggins, Halstead, and H. Horsnaill, Witham—Millstones
218 L. J. Crossley, and R. Hanson, Halifax—Steaming printed yarns
219 H. H. Murdoch, Staple Inn—Smelting copper.—A com.
220 B. Mountain, T. Richmond, and G. Duffield, Leeds—Boots and shoes
221 J. Dinsdale, Skipton—Spinning machinery

25th January, 1869.

222 J. M. Merrick, Massachusetts—Useful composition
223 W. M. Welling, New York—Compositions resembling ivory
224 C. Toucheireux, Paris—Ear-ring hinges
225 C. B. Parkinson, A. and J. Metcalfe, and W. H. Heald, Preston—Spinning mules
226 R. G. Lowndes, Auldbrebasefield, and M. M'Callum, Barrhead—Finishing textile fabrics
227 C. E. Brooman, Fleet Street—Cocks or valves.—A com.
228 W. E. Newton, Chancery Lane—Stamping sheet metal.—A com.
229 J. Carr, Manchester—Venetian blind tapes
230 A. V. Newton, Chancery Lane—Fermenting substances.—A com.
231 E Hartley, Oldham—Looms for weaving
232 H. D. Bowyer, Woking—Wheaten flour
233 R. J. Green, Birmingham—Collar studs
234 J. and S. Roberts, West Bromwich—Moulds for casting
235 H. W. and R. Lafferty, Gloucester—Centrifugal machines

26th January, 1869.

236 C. L. Wood, Bishop Auckland, and J. Hockley, Newcastle-on-Tyne—Grinding plate glass
237 E. D. Ruston and W. W. Mills, Birmingham—Window sashes
238 J. D. Ellis, Sheffield—Rolling armour plates
239 J. and J. Wilson, and G. Cryer, Kildwick—Finishing wool
240 J. Millar, Cambridge Road—Envelopes
241 J. Wilson, Poppleton—Shaking straw
242 J. Pickering, Glasgow—Treating timber
243 W. R. Lake, Chancery Lane—Ventilating apparatus.—A com.
244 A. V. Newton, Chancery Lane—Cutting veneers.—A com.
245 H. Law, Strand—Connecting pipes
246 C. Gil, Paris—Sugar.

27th January, 1869.

247 C. French, Blandford Square—Intercommunication on railway trains
218 C. Mather, Salford—Singeing fabrics
249 T. Reeder, Preston Street—Metal rollers
250 J. Gough, Hatton Garden—Applying ink to printing surfaces
251 J. Taylor, Birkenhead—Propelling ships
252 T. Vaughan, Middlesborough-on-Tees, and J. W. Smith. Manchester—Treating soot
253 H. Barcroft, Newry—Damasks
254 J. Porteous, Edinburgh, and H. Gibson, Musselburgh—Tobacco
255 T. Brown, Newgate Street—Liquid-discharging apparatus.—A com.
256 J. H. Johnson, Lincoln's Inn Fields—Railway keys.—A com.
257 R. Girdwood, Edinburgh—Envelopes
258 E. H. Prentice, Stowmarket—Phosphatic manures
259 J. Silman, Birmingham—Boot-cutting rives
260 G. Tangye, Birmingham—Letter-copying presses
261 C. Lungley, Greenwich—Caissons and pontoons
262 A. C. Pass, Bristol—Purifying metallic vapours
263 C. W. Petersen, Norton Folgate—Life-boats

28th January, 1869.

264 R. M. Marchant, Torrington Square—Obtaining power
265 W. Spurrier, Birmingham—Salt spoons
266 W. Brown, and T. H. Garbutt, Scarborough—Fire-bars
267 R. Jones, Botolph Lane—Preserving animal substances
268 E. D. Abel, Chancery Lane—Washing textile fabrics.—A com.
269 C. L. A. Hoelscher, Geneva—Musical chair
270 R. Blackbee, Dalston—Pessary
271 A. Browne, King William Street—Rotatory engine.—A com.
272 L. P. Hébert and L. A. Moulin, Neuilly-on-Seine—Letterpress
273 J. Box, South Sea House—Destroying burrs in wool

29th January, 1869.

274 J. Easterbrook, J. H. Allcard, and A. M. Wild, Sheffield—Polishing engine slide bars
275 N. C. Szerelmey, Pimlico—Making tarpauling in different colours
276 G. Hawksley, Caledonian Road—Chimney pots
277 W. MacLean, Glasgow—Printing machinery
278 J. Pickering, Glasgow—Propelling ships
279 T. W. Carter, Gray's Inn Road—Constructing ships
280 J. M'Donald, Hackney—Bottle stoppers
281 S. Smith, Nottingham—Steam-valves
282 G. Hawksley, Caledonian Road—Pumps
283 G. Price, Birmingham—Window fastenings
284 J. H. Johnson, Lincoln's Inn Fields—Iron billets.—A com.
285 A. M. Clark, Chancery Lane—Hulling grain.—A com.
286 A. Mallard, Moorgate Street—Horse shoes.—A com.
287 F. Jay, South Lambeth Road—Oil paint

30th January, 1869.

288 T. E. Lundy and T. Hood, City Road—Sewing machines
289 T. Whimster, Perth—Forcing gaseous bodies
290 P. J. Wielemans, Leicester Square—Ovens
291 W. Weldon, Highgate—Manufacturing chlorine and oxygen
292 T. Pimbley, Camden Town—Alarm communication in trains
293 S Taylor, Sheffield, and G. W. Dyson, Tinsley—Spade moulds
294 H. N. Nissen, Mark Lane—Bankers' cheques
295 K. C. Watson, Glasgow—Boats
296 E. T. Hughes, Chancery Lane—File-planing machine.—A com.
297 E. T. Hughes, Chancery Lane—File-cutting machine.—A com.
298 R. Wood, Halifax—Steam-engines
299 J. Tolson, Huddersfield—Carding-engines
300 G. H. Adam, Birmingham—Ascertaining condition of trains
301 T. H. Kilner, Lepton—Condensing machinery
302 A. S. Andrews, Old Street—Horse collars

1st February, 1869.

303 J. T. Bintley, Kendal—Billiard tables
304 J. White, Hoxton—Tailors' shears
305 C. D. Abel, Chancery Lane—Casting ingots,—A com.
306 T. G. Daw, Regent Street—Stereotype matrices
397 J. A. Limbert, Gravesend—Raising heavy bodies
308 A. V. Newton, Chancery Lane—Condensing silvers.—A com.
309 J. A. A. Fontaine, Strand—Hydrostatic hoist

2nd February, 1869.

310 R. Caunce, Mansfield, and M. G. and B. Bradley, Nottingham—Twisting yarns
311 C. Hoult, Wolverhampton—Screens or shields
312 A. Barclay, Kilmarnock—Ejector condensers
313 J. Proud, Carlisle—Basket cars
314 N. Voice, Handcross—Regulating the flow of water
315 D. Joy, Saltburn—Extracting oils
316 S. Brooke, Brighouse—Carding engines
317 A. E. Harris, Mile End Road—Artificial teeth
318 W. J. Palmer, and W. P. Goulding, Reading—Calcining alkaline solutions
319 W. A. Smith, Manchester—Preserving meat
320 J. Bird, Kingswinford—Burning bricks
321 W. E. Newton, Chancery Lane—Railroads.—A com.
322 H. Bate, Hackney Road—Tops
323 C. W. Brabazon, Malahide—Oyster chain net

3rd February, 1869.

324 V. Baker, Aldershott—Vessels for containing hot liquids
325 J. Slater, Euston Road—Railway carriages
326 J. G. Willans, Paddington—Iron and steel
327 J. Macintosh, Regent's Park—Ornamenting surfaces
328 J. H. Tyrrell, Rochford—Measuring liquids
329 A. S. and A. R. Stocker, Horsleydown—Infants' feeding bottles
330 C. D. Abel, Chancery Lane—Hydraulic cement.—A com.
331 F. Vanderaey, Belgium—Bricks
332 C. E. Brooman, Fleet Street—Corsets.—A com.
333 W. Lister, Liverpool—Filtering saccharine solutions.—A com.
334 W. Maddick, Manchester—Internal fire tubes of locomotive boilers
335 R. R. Frohock, Boston—Making lasts
336 J. R. Johnson, Haymarket—Photographic pictures
337 L. Wray, Ramsgate—Hardening wrought iron
338 A. V. Newton, Chancery Lane—Sewing machinery.—A com.
339 J. Howard, Bedford—Turn-wrest ploughs

4th February, 1869.

340 H. and J. Bryceson, and T. H. Morten, St. Pancras—Organs
341 T. Parkinson, Liverpool—Admitting air to furnaces
342 J. J. Bagshawe, Sheffield, and W. F. Batho, Birmingham—Flour
343 E. D'Artois, Fitzroy Square—D'Artois' inkstand
334 F. and T. Pankhurst, Chatham—Gully traps
345 E. Lord, Todmorden—Furnaces
346 P. Jensen, Finsbury Square—Utilizing motion of waves
347 R. W. Knowles and G. Green, Bolton—Finishing muslins
348 J. Vavasseur, Southwark Street—Working heavy guns
349 E. Morewood, Briton Ferry—Tin plates
350 G. Bray, Deptford—Slip hook
351 W. E. Newton, Chancery Lane—Elevated railways.—A com.
352 H. Jones, St. Marylebone—Sounding tuning forks

5th February, 1869.

353 G. and E. Ashworth, Manchester—Paper fasteners
354 J. Jobson, Derby—Explosive projectiles
355 F. Braby, Camberwell—Sulphate of iron
356 W. Blundell, Upper Thames Street—Chimney guards
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